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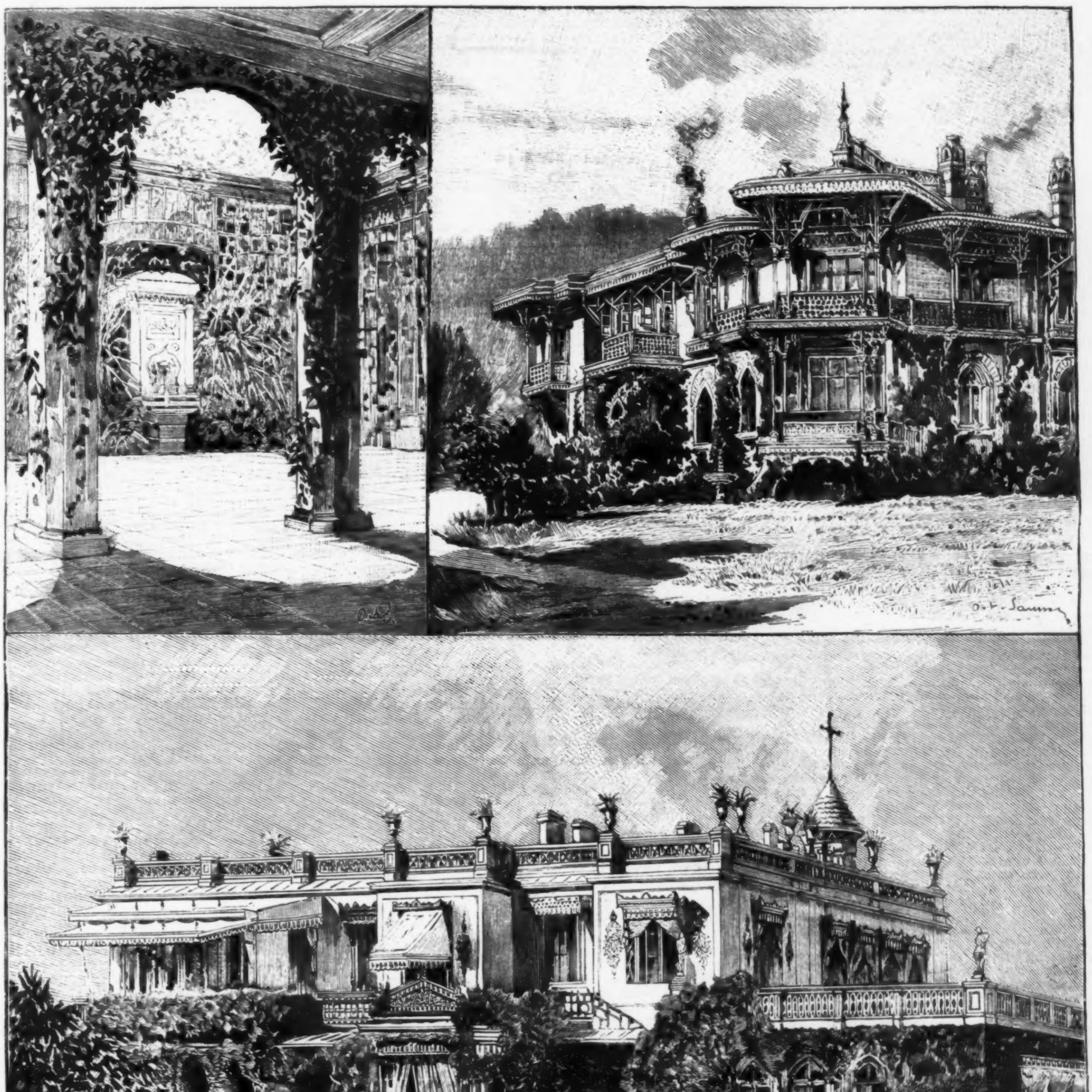


1. The winter garden. 2. Cottage of the Empress. 3. The palace.

LIVADIA—RESIDENCE OF THE EMPEROR OF RUSSIA.

THE IMPERIAL RESIDENCE AT LIVADIA.

ON the palace at Livadia, in the Crimea, the thoughts of the whole civilized world were fixed when the news was flashed around the world that Alexander III., Czar of Russia, had expired there at three o'clock on the afternoon of November 1. Since the time of Peter the Great no male ruler of Russia has died a natural death until the recent decease of Alexander III. The late Czar of all the Russias became ruler of Russia after the death of his father, Alexander II., who was killed by a Nihilist bomb on the Nevski Prospekt, in St. Petersburg, March 13, 1881. Alexander III. was thirty-six years old when he succeeded to the throne, consequently he was forty nine when he died. His mother was Princess Maria, of Hesse-Darmstadt. His wife was the Princess Maria Dagmar, of Denmark, fourth child of King Christian, and sister to the Prince of Wales. The late Czar was 6 feet 4 inches in his stockings and weighed 250 pounds. He had enormous strength. For thirteen years the man who held the peace of Europe in his hand was menaced by Nihilists, so that even his car was protected by plates of steel hidden under the costly woodwork. Alexander had five children, the Czarowitz Grand Duke Nicholas, who succeeds him as Czar of all the Russias, under the title of Nicholas II., and was born May 18, 1868; Grand Duke George, born May 9, 1871; Grand Duchess Xenia, born April 6, 1875; Grand Duke Michel, born November, 1878; and the Grand Duchess Olga, born June 13 1882.

The new Czar is short in stature and very unlike his father in appearance. He made a solemn vow to carry on the government on the peaceful lines laid down by his father, and he has the comforting assurance that the Nihilists have already threatened his life. His bride-elect is Princess Alix, of Hesse.

Livadia, near Yalta, in the Crimea, is a simple villa in an immense park, and through the forest can be seen the waters of the Black Sea, which are in reality of deep blue. Climbing plants attach themselves to the walls of the small palace. A winter garden almost entirely surrounds it, and it is only a Greek chapel with its bulbous bell tower that indicates that we are still in Russia. It seems rather that we are at the country house of a rich merchant in the neighborhood of Stuttgart or Heidelberg.

The ground floor of the chateau of Livadia contains the reception rooms; the first floor was devoted to the apartments of the Emperor and Empress. A small chalet, three-quarters of a mile from Livadia, is where the Empress has passed much of her time the last few weeks plunged in the deepest grief. The Empress has decorated and ornamented this charming solitude with her own hands. In the park are found various buildings for the lodging of officers, barracks, schools, hunting lodges, concert halls, concert pavilions, for military bands, etc. In a word, Livadia is one of the most agreeable residences which the imperial family possess in the South. For our illustrations we are indebted to Le Monde Illustré.

SKELETON CONSTRUCTION AND THE FIRE DEPARTMENT.*

SEVEN hundred and fifty years ago, a little knot of architects were busy with the solution of a new problem. All of them had been educated under the same conditions, had been taught the same rules, had copied the same models, and studied the same methods of construction. Now, to all of them, almost simultaneously, had been presented a new set of conditions, which must be fulfilled, but in the fulfillment of which the models upon which their instruction had been based gave them little assistance. Those models expressed, by their thick walls, heavy piers, horizontal lines, and small, round arched openings, solidity, calm, dignified seclusion and aristocratic sanctity; and now had suddenly arisen in the community a fever of revolt against aristocratic and sacerdotal exclusiveness, a passion of democratic feeling, to which the narrowness and heaviness of Benedictine architecture were intolerable. Everywhere was heard the demand for air, space and light, for vast, bright, open halls, in place of the gloomy monastic churches in which the laity, for five centuries, had been permitted only to listen, from behind a screen, to the prayers of those holy persons whom alone the Saviour of mankind permitted to approach His altar. In one word, the modern spirit had been born, and upon a few men had fallen the task of expressing it in architecture. You all know how they acquitted themselves of this duty; how, starting with the necessity before them of providing vast and lofty buildings, with slenderer supports and larger windows than had ever been seen before, they not only completely satisfied these requirements, but, almost within one man's lifetime, developed a style of architecture absolutely new, even to its smallest detail, and in this style produced buildings which, speaking to architects trained to appreciate many sorts of architectural beauty, I will not call the most beautiful in the world, but which may be justly described as the most interesting in the world, through the richness of artistic feeling which shows itself everywhere in them.

A comparison of the last decade of the nineteenth century with the era of the emancipation of the communes may seem historically unwarranted, but, architecturally, there are some striking points of similarity. With us, as with the people of Paris and Amiens and Rouen toward the end of the twelfth century, buildings of the sort that our grandfathers erected no longer serve our purposes. It is true that we can use their dwelling houses comfortably enough, but, for the occupations and amusements which we carry on in common with other people, we need, and must have, stronger, lighter, more wholesome and more enduring structures than any known to our forefathers. As economy of time must be practiced to the utmost in our modern system, each sort of business must be as far as possible localized; and this involves collecting near a given spot as many persons, whose interests are connected with that locality, as can safely be accommodated; this requirement alone bringing us inevitably to the modern high building, with its many stories, and its swift running elevators, standing upon a lot whose situation alone gives it fabulous value.

Notwithstanding all that has been said in ridicule of the "sky scrapers," there is no doubt that these high buildings meet a need that has been urgently felt, and will continue to be felt more and more in our large cities; and, however conservative we may be in our notions of the virtues of six stories of solid wall, we all know that the buildings that the age requires, standing on land worth two hundred dollars a square foot, must be made with protected metallic skeletons, and we have probably prepared ourselves, by earnest study of the subject, to make the best of the new construction, whether it appeals to our artistic sympathies or not. That it should at once appeal to our artistic sympathies is not particularly to be desired. The people who cast off the old love with most alacrity are not those who gain the firmest hold on the affections of the new one; and a regard, based on an appreciation of the many excellent qualities of the new architecture, will be the best foundation for an esteem which, we may hope, will hereafter find artistic expression.

Among these excellent qualities, the greatest ought to be, and will be, if architects choose to have it so, the security of the modern high building against fire. As a rule, fire engineers are disposed to condemn those already erected, for the reason that they are so lofty that streams of water cannot be thrown into them, and so incautiously built, in many cases, as to present an immense mass of fuel, in a condition for burning comparable with that of a pile of kindlings built up in a chimney; and they are certainly justified in their criticism; but there is no necessity for filling these blast furnaces with woodwork, and, where the architect is allowed to apply his knowledge, it is easy to make the protected skeleton, of fifteen or twenty stories, not only safe against injury by fire within, but extremely valuable as a bulwark against the course of conflagrations outside it. In the presence of so many of my brethren, much better qualified than myself to treat of the details of the new construction, I will not presume to point out the methods which architects should follow in carrying out designs of the sort here considered, but it will do no harm to suggest certain possibilities, in the way of application of materials, which may contribute in new ways to the diminution of the fire hazard. It is well understood by architects that no building, however constructed, is safe against fire, unless the amount of combustible material contained in it is either very small or is divided into small portions by incombustible partitions; and it is also well known that a building, very safe against internal hazards, may be destroyed by the attack of a fierce conflagration from the outside. Great as has been the progress in the art of incombustible construction within the last ten years, there is still much that can be done, with materials already at hand, in fortifying our lofty buildings against both internal and external risks. Where the fireproof building of ten years ago had its partitions set with wooden studs, filled in with blocks of hollow plaster or porous terra cotta, and its wooden doors and windows trimmed with wooden architraves, the modern structure is divided by partitions of cement on metallic lath, held by uprights of channel or angle iron, or of wrought iron pipe, and, in many cases, provides iron frames and casings for its doors and windows; and the fireproof building of the future will undoubtedly add to these, either doors entirely of metal and glass, such as are made in Germany, and occasionally here, or of wood, covered with sheet metal, in the manner recently introduced, which gives a light, handsome and perfectly incombustible door, at a very small expense.

With marble floors, on concrete or terra cotta arches, between iron beams, plenty of partitions of iron and cement, metal covered doors and windows hung in iron frames, and bases and wainscoting either of marble or of metal cased wood, the internal hazard of the high fireproof building can be reduced to almost nothing, as a fire in one room could not spread to the next. There is, however, the external hazard still to provide for, and here, also, there is still some progress to be made. Obviously, the most vulnerable point in such buildings is to be found in the windows, which, as at present made, offer no resistance whatever to a fire outside. For skylights we have found in the new wire glass, a material at once transparent and fire resisting, and there seems to be no reason why a similar material should not be used in the windows in the vertical, as well as the horizontal walls. Of course, it is not to be expected that the tenants of a great office building would be satisfied with the ordinary wire glass for their windows; but there is nothing to prevent us from designing the most beautiful lace work of which we can conceive, and having it executed in gilded or silvered wire, and embedded in the polished plate glass of the windows of our "sky scraper" buildings. Such treatment, whether the tenants liked it or not, would add greatly to the external appearance of such buildings, and would render them practically secure, no matter how numerous or ample the openings, against fire from the outside, as the glass, held by the wire network, would keep its place until it was melted away.

Again, we are told by the fire engineers that the brick and terra cotta with which we clothe the steel skeleton of our new buildings are liable to destruction by the combined effect of heat and water, and that, when exposed to a serious conflagration, either from the inside or the outside, they are likely to fall off, and expose the steel structure. Experience has shown that there is truth in this, but it does not follow that high building must be condemned in consequence. Our mediæval brethren, in attempting to adapt their old round arched models to their new conditions, found that their buildings generally fell down. Did they for this reason desist from their attempts to solve the problem imposed on them? No. They knew, as we know, that the problem must be solved; and to solve it they at last invented a form of arch which had never been seen before since the beginning of the world. So strange and outlandish did this arch appear to them that for years, although they were compelled by constructive necessity to use it, and did use it with great skill, they disguised it, so that no one should notice that their buildings contained anything but the round arch of their forefathers. In the same way, if brick, stone and terra cotta cannot be made to protect efficiently the metal framework of the buildings which we are trying to make fireproof, something else, that will accomplish this object, will assuredly be employed, no matter how much our traditions, may have to be upset for the purpose. For example, there is no practical reason why a steel skeleton should not be clothed first with cement mortar, on iron lath, and then cased entirely over with copper, or brass, or aluminum, riveted at the joints. With a little grouting between the steel work and the casing, to give a substantial backing to the sheet metal, a building of this sort would be almost indestructible. Fire and water would expend their force upon it in vain, centuries of exposure to the weather would only increase the beauty of its patina, and, if well anchored to the ground, and cross braced with moderate skill, no earthquake could bring it down. It would be a queer looking affair, no doubt, and the critics would have plenty of sport at its expense; but we may remember, in our efforts to accomplish, by the light of our own intelligence, the results that are required of us, that it was the ugliest of the ducklings that grew up to be a swan, and that in the solution of the most important, most difficult, and yet most imperious problem that confronts us certainly lies, to a great extent, the future of the art of architecture in America.

* A paper by T. M. Clark, F.A.I.A., read before the American Institute of Architects at their twenty-eighth annual convention.—American Architect.

THE PROPOSED DEEP WATERWAY FROM THE GREAT LAKES TO THE OCEAN.*

By First Lieut. WENDELL L. SIMPSON, 9th U. S. Infantry.

A PROJECT for a deep waterway to connect the Great Lakes with tide water has of late been somewhat prominently before the public. Men of capital and influence are interested, conventions have been called, a general congress with representatives from many commercial interests and several States has been in session, and that the project may at no distant day materialize seems probable.

Many years ago the Erie Canal was projected, and though purely a State undertaking, it was carried through to completion. Its importance outside the State of New York was scarcely recognized in the days of its inception, and its most enthusiastic advocates underestimated the importance of the part it was to play in commercial affairs.

As the great Western interior was settled and developed, the center of agricultural production moved westward. The productions of this vast territory have rapidly increased even in proportion to local consumption, and the question of cheaper transportation to Eastern markets has become one of grave importance. Notwithstanding the almost endless network of railroads reaching out and gathering in the immense product to the great commercial centers for distribution, the conditions are far from satisfactory to those interested in the production. The actual expense of long-distance shipments by rail, the expense incident to the necessity of breaking bulk and making transfer in shipment to distant points, and the obstacles in the way to free competition resulting from railroad combinations, deals and monopolies, one and all, serve to counteract the advantages of cheap land and cheap production.

During the summer of 1892, when wheat was quoted in New York from eighty to eighty-five cents per bushel, a Nebraska paper quoted prime wheat at forty cents. This is a startling difference in this day and age to be due to cost of transportation only, and the financial meaning of such a difference becomes apparent with a brief comparison of shipping statistics. The immensity of the shipping of the Great Lakes is scarcely comprehended by those who have not made a careful study of the subject.

One eighth of the entire commerce of the United States passes through the St. Mary's Falls Canal. The tonnage that passed through this canal in 1891 exceeded by over 2,000,000 tons the entire freight of all nations that passed through the Suez Canal during that year.

More tonnage passes the city of Detroit than any other point in the world. In 1889 there were nearly 10,000,000 tons more than the total entrances and clearances of all United States seaports, and nearly 3,000,000 tons more than the aggregate shipping of London and Liverpool; and this latter excess was increased to 10,000,000 tons the following year.

A great portion of this freight is destined for Eastern markets and gains an outlet through New York or Montreal. For the former point it must be reshipped by rail or by the Erie Canal, and for the latter it passes through the St. Lawrence and Welland Canals. The disadvantages of the New York route are apparent. The disadvantages of the Montreal route become apparent when one learns that boats representing one-half the tonnage of the lake traffic are of too great draught to pass through the Welland Canal, and that there are many of the boats that can pass the Welland that cannot pass the St. Lawrence canals.

With these facts before us, no good reason is apparent why a deep waterway is not already in process of construction. Our people are not slow to recognize commercial advantages, nor are they slow to act in securing them, especially when immediate financial benefits are sure to follow. With the need so urgent, the interests involved so extensive, yet at the same time no action, an opposing interest is naturally looked for; but no opposing interest is apparent unless it is that of the railroads. The project, from a commercial basis, is not merely of local importance. It is not a matter of securing deep water transportation between two given points and along the connecting line only, but also and primarily of securing the conditions to render it practicable to load several hundred miles nearer the place of production for distant points, and to load on such transport vehicles as shall reduce the actual cost of transportation, do away with the necessity of breaking bulk or transferring in transit, and establish a wholesome competition to railroad traffic. Under present conditions the railroad companies own and control many of the lines of carriers on the lakes, and with their connecting railroad lines control to a great extent the lake shipping rates. With a through waterway from the West, open to all craft, and independent of connecting railroads, the natural laws of competi-

* From the Journal of the Military Service Institution.

tion would quickly regulate the rates to a standard of "Live and let live."

The enterprise is one of immense financial magnitude; but considering the changed conditions, the wealth of the country as compared with earlier times, and the capital to be affected directly, it is no more of an undertaking than was in its day the construction of the Erie Canal.

In the accomplishment of this project its friends and advocates see a way to realize the objects set forth. With a deep waterway connecting Lake Ontario with the Hudson River, and another connecting Lake Ontario and Lake Erie, both entirely within United States territory, they see ocean ships loading at Chicago or Milwaukee or at any other lake port, not only for our Eastern and Southern seaports, but for any foreign port to which commercial conditions render it desirable to transport our products. Then with a widening and deepening of the Illinois Canal, they see the system and its benefits extended to the Mississippi River.

In this country commercial necessity alone can carry through such a project. When it becomes evident that business interests will warrant such an undertaking, then, and then only, will the project materialize. Will it pay in dollars and cents? is the test question to be applied to such an enterprise; and when it will, the powers act. The hills are leveled and the hollows are filled up; in fact, anything seems possible with this condition at the outset.

The United States seldom makes extensive and expensive preparations for military reasons only, until the absolute and immediate necessity exists; and then the element of time steps in as a dictator to say that this or that cannot be done. It would be useless, therefore, to urge the value of a deep waterway from a military point of view as a reason sufficient for its construction. It could in no way be a ninety days measure. When, however, the time is ripe for the enterprise, as determined by commercial interests, the United States should foster and promote the work with an interest beyond that of financial gain to the citizens and the State. If, as it may appear, the time is already at hand, and the measure is being held in check by railroad interests, the government should give due weight to the great military advantage secured, take the matter in hand, silence opposition and push the construction to completion as speedily as possible.

MILITARY IMPORTANCE.

However much civilized nations may be opposed to war in general, the nation best prepared to enforce her demands and maintain her rights will meet with the greatest courtesy and consideration from other nations, and command the greatest respect. How many war ships and gunboats are ready to speak in this request? is a question that all take into consideration. There is no native courtesy among nations. It is all artificial, a matter of policy; but expected, required, enforced. A nation that neglects to provide and maintain the means to enforce must cease to require, and may no longer expect. No nation can afford this neglect. It is shortsighted economy.

In our country there has always been some effort to keep up a naval force and provide coast defenses. Following the sudden changes of naval construction and coast defenses incident to modern improvements in armament and increased speed in navigation, we fell fearfully behind the times in such matters; but during the last decade there has been a sufficient effort in building war ships and improving coast defenses to show that there is still an inclination to provide the wherewith to rest a proper national dignity. With a continuation of this policy for a few years, our sea coast will be fairly protected. Though the coast is of great extent, the important harbors are few—twenty-seven in all—and the naval force will be large enough to act with and support such coast defenses as may be built to protect these harbors. While this policy is being carried out, however, not a step is being taken to provide for the defense of our Northern frontier. Here for three thousand miles we are practically in contact with foreign territory pertaining to a country strong in military and naval resources. Along 1,300 miles of this frontier lie the Great Lakes and their connecting waterways, which, forming an apparent natural barrier, really makes the problem of effective defense much more complicated than it could be were it all inland frontier. The conformation of the lakes extends this 1,300 miles of frontier line into 2,000 miles of coast; an extent equal to our entire Atlantic coast. Along the lake front are distributed towns and cities of great wealth, which are distributing and shipping centers of an immense territory, thickly settled, productive, and wealthy. These towns and the producing tracts that they represent furnish, as has been shown, over one half the commerce of the United States. With these facts in view, nothing further would be necessary to show the importance of this coast, or the great advantage, in the event of war with England, that the possession and control of the lakes would be to the one power or the other. In our possession it would mean a complete protection of all this wealth and shipping, a warrant for the continuation of the great production of the Northwest, a control of Canadian lake ports, and the advantages that this would give for invasion. In the possession of England it would mean either a total destruction or control of these important towns and the entire lake shipping, a safe rendezvous where forces could be collected with undisputed lines for concentration and supply, practically in the very interior of our territory.

There could be no division of this control and possession as has been in the past. The first power to place a naval force on the lakes could hold possession to the end. The avenues of approach are contracted and easily guarded by the power in possession. They might be destroyed or made impracticable, but that would be of minor moment to the possessor. No ship building could be carried on in opposition to the controlling power, while any amount could be effected under its protection. No coast defenses of importance could be built to oppose a destroying fleet, while similar work could be undertaken by the enemy with impunity. Finally, no ready constructed land defense, without the support of war vessels, would be of avail to protect the harbors and coast towns. The coast is flat and ill adapted to land defenses at best. If the defense be placed on the water front of a town, the destruction of the town would not thereby be prevented. The very fire drawn by the defenses would, to a great extent, take effect on the town itself. If the defenses be established on the flanks, they would still be ineffective to save the town. An attacking fleet could, in this case, after coming within range of the defenses, move to a point much nearer the town without materially lessening the distance from the defenses. Moreover, when once in possession of the lakes, the action could be so prompt as to destroy or lay under contribution every important town on the coast before anything further than the preliminary steps of providing defense could be taken. The wealth thus placed at the mercy of the opposing power would be immense.

The commercial interests and wealth on the lake coast in the United States is far greater than on the Canadian side. Leaving this fact out of consideration, the possession of the lakes in case of war is of about equal strategic importance to the two countries. One would be led to suppose that the importance of these interests combined would lead the United States to be sure to provide means of securing possession of the lakes in event of war at least equal to those available to England. This has not been done. By the way of the St. Lawrence River and St. Lawrence canals and the Welland Canal, England can place a naval force upon the lakes in short order. These canals are entirely within Canadian territory. The part of the St. Lawrence to be traversed not within Canadian territory is to a great extent too wide or too thickly dotted with rocky wooded islands to permit any effective resistance being offered by land forces to the passage of a fleet. The narrowest part of the river is of sufficient width to make effective resistance impracticable on short notice or with a small force. In regard to the canal locks, the real key to this line of advance and communication, England has facilities for protection for a short period superior to our facilities for destruction. Add to this the presence of a fleet passing to the lakes, and the possibility of our accomplishing an injury to the locks in time to prevent the passage of the fleet becomes very small.

The defense would act with full knowledge of the importance of the end to be attained and of the short space of time that the defense would be necessary. The short time needed would be greatly to their advantage, as no considerable force could be collected to oppose them within this limit. The day once passed, the purpose would be accomplished, and the destruction or control of the locks would then be without advantageous effect other than to prevent the immediate re-enforcement of the force already on the lakes. This would be of comparatively little injury, as the power that gains possession of the lakes has everything at hand that is necessary to provide re enforcements. Control is at once gained over an immense carrying power to transport material and supplies, and the work of converting lake vessels into engines of war and building new vessels, if desired, may be pursued undisturbed. For forty-four miles only on the St. Lawrence is canal navigation necessary. Allowing four miles per hour on the canals and ten miles per hour for the intervening portions of the river, which aggregate sixty-eight miles, less than eighteen hours would be required to pass from Montreal to the open river above the upper rapids. Allowing liberally for delays in getting a somewhat extensive fleet under way and for the working of the locks, it would not take two days to pass a fleet of one hundred vessels over this part of the route to the lakes.

By the provisions of a treaty made in 1817, both the United States and England are prohibited from placing war vessels on the Great Lakes, except to the slight extent provided for in the treaty, the exceptions being the same for each country. Through the St. Lawrence and the canals, however, England has provided an approach to the lakes, and nothing in the treaty prevents her from assembling a fleet at Montreal or even in Alexandria Bay, within a few miles of Kingston. In this manner England may practically hold possession of the lakes before war is declared. This is the possibility most favorable to England. On the other extreme, suppose the start be made from the British coast. Even in that case fourteen days is sufficient time for England to place a fleet in possession. If the canals can be held for that time, their main mission will have been fulfilled.

The smallest locks on the St. Lawrence canals are 200 ft. long, 45 ft. wide, and 9 ft. deep, and all have been built with a view of enlarging to 280 ft. long, 45 ft. wide, and 14 ft. deep.

From the U. S. Naval Bureau of Information the statement is obtained that England has 57 war vessels drawing over 9 ft. and less than 12 ft.; 10 drawing over 7 ft. and less than 9 ft.; and 44 drawing less than 7 ft.; 54 vessels could, therefore, pass the canals rapidly and without delay, and 57 more could be passed by removing ballast and armament. One hundred and eleven vessels are to be considered as at once available for service on the lakes, all with modern armament, and several of them well armored. Add to this the auxiliaries that could be rapidly transported to meet the fleet on the lakes, torpedo boats, armament, supplies, crews, marines, and it will be seen that a formidable force could be ready for action in a remarkably short time.

The work of enlarging the canals and locks is provided for. Two of the canals already have locks 270 ft. long, 45 ft. wide, and 14 ft. deep. With the completion of this work, a much larger fleet and more powerful vessels could be sent to the lakes, if desired.

The Welland Canal is entirely beyond the reach of our country, except by invasion by the lakes, or by crossing the Niagara River. The smallest locks of this canal are 280 ft. long, 45 ft. wide, and 14 ft. deep. An English fleet on Lake Ontario could, therefore, take possession of Lake Erie at once, while a United States fleet coming by the way of Lake Ontario would be promptly cut off from Lake Erie by the destruction of the locks on the Welland before the fleet could reach that canal.

To be sure, the passage from Lake Erie to Lake Huron could be quickly rendered temporarily impracticable by obstructing the canal through the St. Clair Flats, and by sinking obstructions along the narrower parts of the channel of the Detroit River, where it might be practicable to bring heavy batteries to bear on the location, provided this could be accomplished in time to prevent the fleet from gaining possession. The chances are perhaps about equal as to which could be accomplished first. To provide for a possible contingency at this point, a canal has been projected leading from Lake St. Clair directly across to Lake Erie, through Canadian territory.

An enemy's fleet on Lake Huron could pass to Lake Superior without serious hindrance, unless the canal of St. Mary's River should have been destroyed. Even here a canal is being constructed giving an independent passage through Canadian territory.

No serious opposition would be met with in passing a fleet from Lake Huron to Lake Michigan, in absence of an opposing fleet.

Having briefly traced the advantages available to England for occupying the Great Lakes, and the probable opposition that could be offered thereto, the other side of the question demands attention.

One can rest assured that in the event of war, or even of threatened war, England would take the necessary precautions to thwart the United States in any effort to make use of the St. Lawrence and canals to place a naval force on the lakes. The many ways available for prevention and delay leave no doubt that this could be most efficiently accomplished. They need only be mentioned, as their efficacy is apparent. This could be effected by previous possession, if time or forethought has permitted; by the delays and damage that might be inflicted at Quebec, Montreal, and other points; and by the destruction of the canal locks as a final resource.

Turning our attention to other entry ways, we find but one—the Erie Canal. Leaving the Hudson River at Troy, this canal connects with Lake Erie at Buffalo. Here communication with Lake Ontario would be blocked, owing to the Welland Canal being in Canadian territory, and being under the control of opposing forces. The only route open to Lake Ontario is by a small canal that branches from the line of the Erie at Syracuse and connects with Lake Ontario at Oswego. By either of these routes considerable time would be consumed on account of the long distance to be covered by means of slow canal navigation. This, in fact, would never have to be considered, as the dimensions of the canal preclude, at the very start, the possibility of its being available as a means of placing effective war vessels on the lakes. The locks on the Erie are 110 ft. long, 18 ft. wide, and 7 ft. deep. Any boats that could be placed on the lakes over a waterway of these dimensions would cut no figure in opposition to a fleet such as has been shown could be brought in by the St. Lawrence. Our one entry way to the lakes sinks into insignificance.

Let the United States construct the deep waterway proposed, with a depth of not less than 21 feet, and locks of length and breadth to correspond; we shall then have much the advantage of England in a race for the possession of the lakes, and can send in war ships of much greater size and power than can be sent in by the St. Lawrence route. At the outside limit, forty-eight hours' steaming from New York will then be sufficient to place a naval force on Lake Ontario. Five hours more, and it may lie off Kingston, and a few hours thereafter the first lock on the St. Lawrence canals may be in our power. If, upon reaching this point, our fleet should have twenty-four hours the advantage of an opposing fleet, we should have a fair chance to gain at once full control of the St. Lawrence, besides being able to accomplish the first and principal move toward the capture of Montreal and Quebec.

The deep waterway is but one of the measures to be considered in connection with plans for the defense of our northern frontier, but it would seem to be of the first and greatest importance. With any treaty in operation that prevents the United States from building and maintaining a fleet on the lakes, no other means of defense would be effective without such a waterway. Even in case the treaty were annulled, it would be poor policy for the United States to go to the expense of building up and maintaining a lake naval force, without providing a way by which this force could be transferred for service elsewhere. The money expended for a deep waterway would render our entire naval establishment available for service on the lakes, and at the same time would provide a great commercial thoroughfare, the benefits of which would be widespread and important.

THE MANCHESTER-THIRLMERE WATERWORKS.

OPENED OCTOBER 13.

THE inauguration of the supply of water from Thirlmere Lake to Manchester marks the completion of a daring enterprise and a memorable engineering work. The problem of supplying towns of rapid growth with an adequate amount of water has always been a pressing one; and Manchester, except very recently, has been a town of phenomenally rapid growth.

At all events, her imperative demand for a more plentiful water supply has been for many years incessant. The old supply from the river Etherow might be increased, and the Longdendale reservoirs might be multiplied, but the fact remained that with a rainfall of about forty-four inches per annum the total available quantity of water which a gathering ground of nineteen thousand acres could supply was no more than thirty-eight million gallons per day, of which thirteen millions and a half were required for what is known as "compensation water," that is, water which is supplied to various persons who had been accustomed to rely upon the ordinary provision of nature, which has probably been disturbed by the machinations of engineers and contractors.

It is not necessary to enter in detail into the circumstances which made the abandonment of the old waterworks as a staple source of supply an absolute necessity. Suffice it to say that the summer of 1873, before the present works were begun, and that of 1887, when they were in full progress, were enough in themselves to give warning to the local authority that there was great danger in leaving the supply in the state in which it then was. It was determined, after processes which may be rapidly passed over, to secure a site in the midst of the Cumberland lakes, where an unfailing supply of water could at all times be obtained and passed on for the use of a great and busy city.

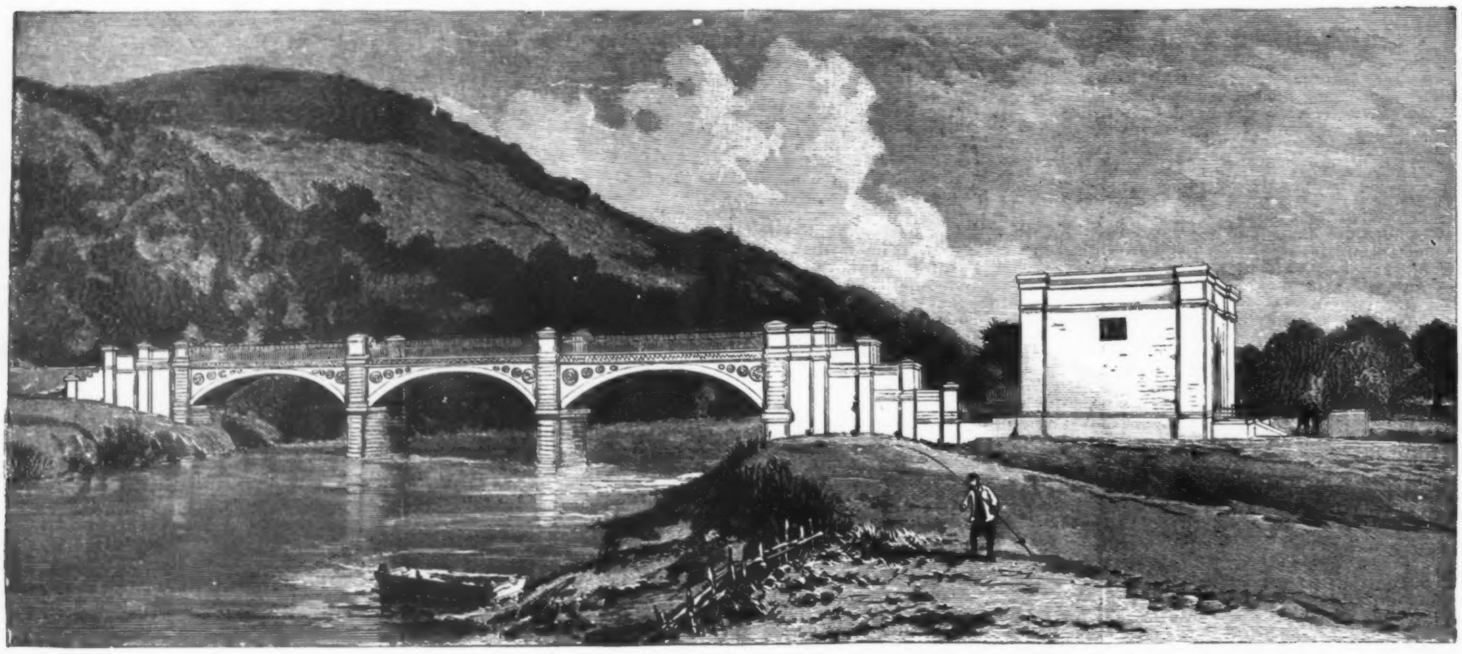
There were but three of the group of lakes that were available for the purpose. These were Ulles-

water, Haweswater, and Thirlmere. After due consideration of the claims of each, it was decided that the last named was pre-eminently suitable for the purpose. It required the raising of a lake already some three hundred and thirty acres in area to an additional height of fifty feet above its former elevation from the sea level, in order to give the water a sufficient "fall" on its way to Manchester, and in order also to increase the storage capacity of the lake by something like two hundred per cent.

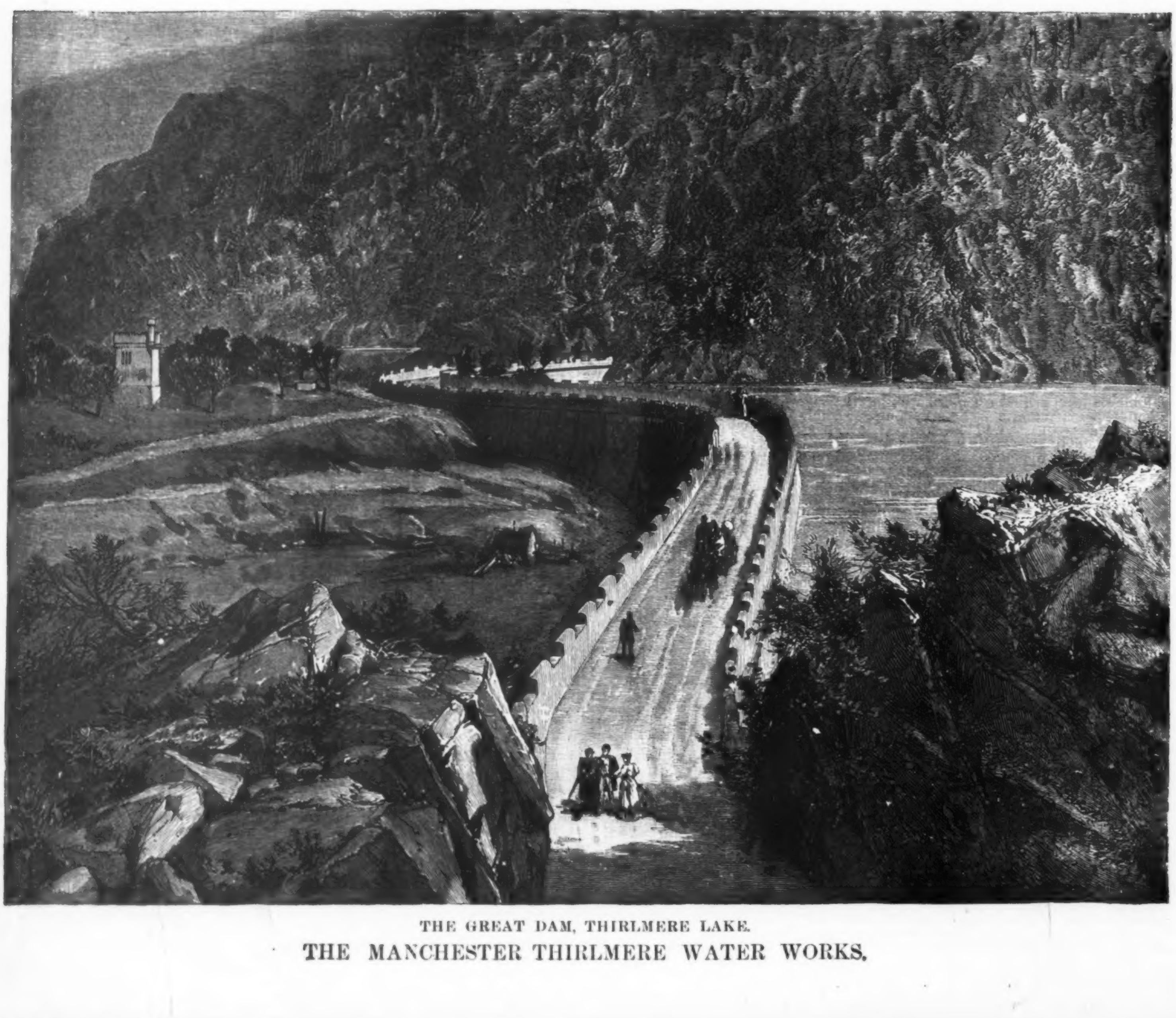
These results were obtained by a complete alteration of the topography of the district. A huge dam, 50 feet wide at its lowest base, and 18½ feet wide at the top, carrying a 16 foot roadway, properly protected with stone parapets, as shown in our illustration, has been constructed, and may be regarded as the initial undertaking in connection with the Thirlmere works. This wall practically incloses and enlarges a gathering ground of hardly more than half the area of that from which Manchester is now accustomed to draw her drinking water. But the area has an average rainfall of about eighty inches per annum, and the result is that after compensation water to the amount of five and a half million gallons has been given to the parties entitled to it, there will be left no less than fifty millions of gallons for the purposes of consumption of the Cotton City.

This could not have been achieved without the transformation or, at any rate, modification of nature's work in many places. October 13, 1894, the water of the lake reached Manchester. One of our illustrations shows the great dam at Lake Thirlmere. Another represents the aqueduct bridge over the river Lune. The water once raised to its new, or, as the geologists would say, old level, it only remained to carry it over the intervening space of nearly a hundred miles, stretching from Cumberland to South Lancashire. Of this distance no less than fifteen per cent. had to be tunneled, the remainder consisting of piping on a large scale or of what is called technically "cut and cover," that is, trenchwork to contain the aqueduct, which is afterward embedded and hidden from sight. In its long journey the water is twice carried over rivers of too great magnitude to be passed by any other means than siphon bridges. These are at the passages of the Ribble and the Lune, and are highly artistic in appearance.

By this long aqueduct have the waters of the lake at the foot of Helvellyn been brought to the heart and center of the city of Manchester; and her citizens fitly commemorate the fact by the turning on, in public fountain, of the bright stream of clear water which is a symbol of the plenty that, for nearly a century, they have sought.—Illustrated London News.



BRIDGE ON WHICH THE PIPES ARE CARRIED OVER THE RIVER LUNE.



THE GREAT DAM, THIRLMERE LAKE.

THE MANCHESTER THIRLMERE WATER WORKS.

APPARATUS FOR HANDLING GRAIN.

THE Conveyor and Elevator Company, of Accrington, has made a specialty of the construction of apparatus for the handling of all sorts of materials in manufactories, etc. There is here a source of great saving in the cost of exploitation when the arrangements are judiciously made.

Long experience in installations of this nature has enabled the company to improve elevators and carriers in such a way as to render them very durable and to permit of obtaining a large rendering with a minimum expenditure of motive power.

Carriers of the screw type are now replacing the old apparatus consisting of iron plates or of endless screws. At the outset, the screw was formed of a bar of round iron, for which a T-iron was afterward substituted; but these two forms were the subject of serious objections, and, after numerous experiments, the company has found that the rectangular section of the

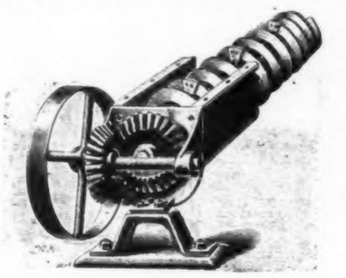


FIG. 1.—SPIRAL CARRIER.

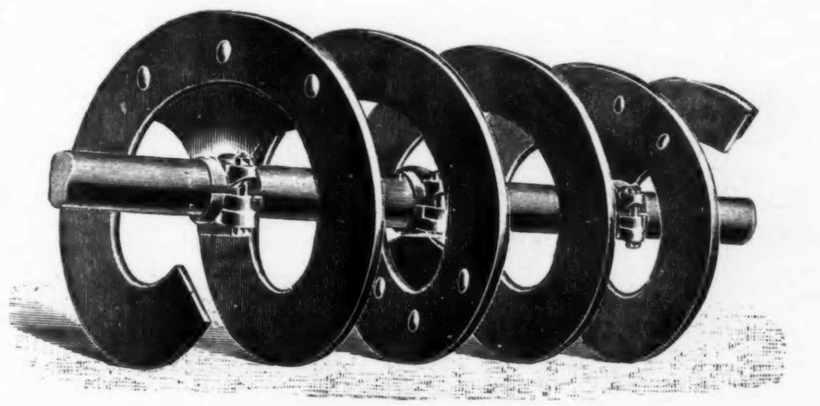


FIG. 2.—PART OF THE SPIRAL.

Stevenson type is the most efficient for the carriage of material with the least friction. The screw is made of hard steel and shaped on a special machine so as to give it an exact and regular pitch, a condition that is necessary in order that the material shall be carried along gently, continuously and easily. This screw is provided with pieces of steel of special form that serve for bolting it to its axis. These pieces not only offer but very little resistance in passing through the material, but aid in the carriage of it, since they constitute a part of the screw. Besides, they present the advantage, in the case of accident, of being able to be removed and changed in a few minutes, without the necessity of taking out any part of the apparatus that shows no wear.

Fig. 1 gives a perspective view of this apparatus, and Fig. 2 shows a certain length of the screw.

The elevators furnished by this English company are constructed with double or single very strong steel chains, of which the type has been studied for the elevation of coal, ore, and other heavy substances. Certain arrangements established with the bearings of the rotary shafts permit of maintaining the tension of the chains to the proper degree.

Three kinds of carriers are constructed by this company, two of them adapted for long distances and substances of a hard and solid nature (such as cement, coal, ore and grain), and the other designed for the handling of light substances (such as flour, bran, sawdust, etc.)

Fig. 3 represents a typical installation for charging and discharging all sorts of materials between a steamer afloat and a lighter. At one of the extremities of the carrier there is a balancing counterpoise, and the other extremity connects with a telescopic chute that ends in the lighter. In Fig. 4 may be seen the installation for the carriage and raising of grain made by the company at Clanrye Mills. As the storehouse is about thirty-five feet from the wharf, an elevator takes the grain from the ship or the lighter and

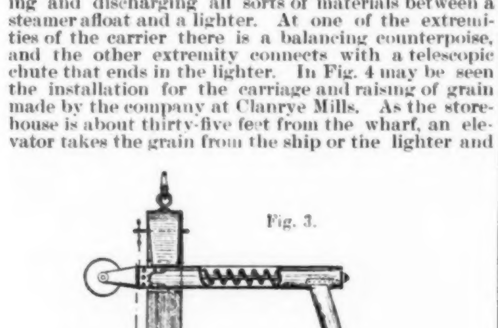


FIG 3.—ARRANGEMENT FOR UNLOADING A VESSEL.

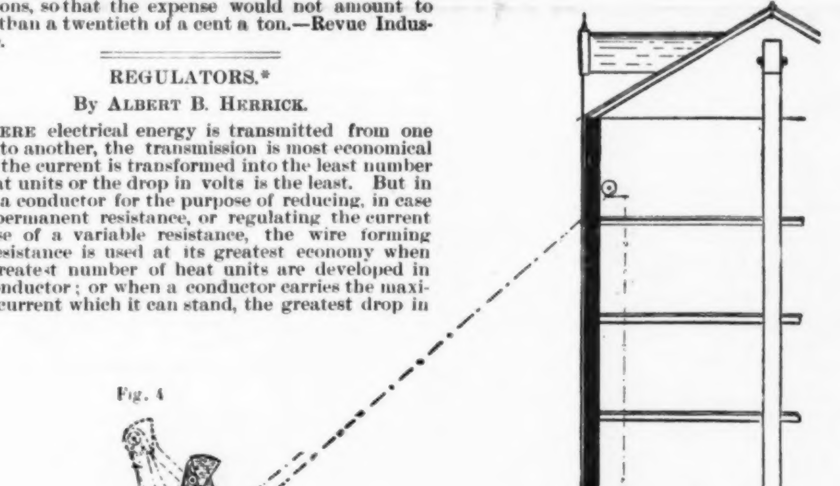


FIG. 4.—ARRANGEMENT FOR DISCHARGING A LIGHTER.

carries it to a telescopic chute, which leads it to an endless belt carrier arranged at sixteen feet above the earth. A screw carrier of steel connects the preceding with the elevator of the storehouse, which, in turn, carries the grain up to the top of the building, where it is discharged. The first elevator is of the double steel chain kind. It is 36 feet in length between the axes and operates in a jacket of one-fifth inch thick steel. There are arrangements provided for assuring a tension of the chains. The buckets are of one-tenth inch thick steel plate, and are 18 inches in length. They are obtained, through stamping, with a special machine tool. This elevator is suspended from journals fixed to an iron frame. Its point of suspension is so arranged that, in running, it can place itself at any angle whatever. A radial arm holds it in a shoe fixed upon the wharf.

A metallic sieve arranged upon the bottom box receives the grain and protects the buckets. The lower shaft is slightly prolonged on each side of the elevator. Two helicoidal steel carriers (having a pitch to the left and right respectively) are arranged on each side so as to carry the material to the buckets, thus diminishing the manual labor in both cases.

The telescopic tube that discharges the grain upon the endless belt carrier has an internal section of 24 by 10 inches. It consists of $\frac{1}{8}$ inch thick steel plates. One of its extremities is jointed with the first elevator and the other with the endless belt carrier. Both are protected against dust.

This carrier is sustained by carriages that move upon lateral rails. Its jacket is of wood with a covering of corrugated iron. It is 28 feet in length and rests externally upon a wooden frame having the form of an A in the interior, and internally against the wall of the storehouse.

The main shafting first actuates this carrier, which afterward communicates motion to the first elevator, whose displacements are obtained by means of a lifting apparatus actuated by the shafting of the mill at the will of a workman on board of the lighter. This installation is capable of handling fifty tons of grain an hour with a six horse motive power. According to certain estimates, the cost of coal does not exceed two cents an hour. It requires two men in the lighter, say at twenty cents an hour, and, finally, the lubricating requires two hours a day, or two cents per fifty tons, so that the expense would not amount to more than a twentieth of a cent a ton.—*Revue Industrielle.*

REGULATORS.*

By ALBERT B. HERRICK.

WHERE electrical energy is transmitted from one point to another, the transmission is most economical when the current is transformed into the least number of heat units or the drop in volts is the least. But in using a conductor for the purpose of reducing, in case of a permanent resistance, or regulating the current in case of a variable resistance, the wire forming this resistance is used at its greatest economy when the greatest number of heat units are developed in the conductor; or when a conductor carries the maximum current which it can stand, the greatest drop in electromotive force is obtained with a given weight of wire. This leads us to the theoretical conclusion that just below the fusing point of the metal forming the resistance is the point at which it is used with the greatest economy in regard to weight and space.

The formulæ which Mr. A. E. Kennelly has deduced from his exhaustive series of experiments on the heating effect of currents in copper, conductors, bare, insulated, and under various practical conditions, leave little to be desired on this point; and, on the other hand, A. H. Pierce's carefully compiled tables, showing the current in amperes required to fuse wires of various diameters and materials, are accurate data on conductors carrying abnormal currents; but in using a conductor for resistance in construction of regulators they have to be worked between these two conditions.

Any conductor can be used as a resistance; but there are a number of practical conditions which arise, and in commercial work there is found only a very limited number used. Liquid conductors with movable electrodes are perhaps one of the oldest forms of regulators. Acidulated water with lead electrodes is very often found to be the most convenient way to make up a resistance for experimental work; a regulator so made gives a fair resistance for rough work; but they are not reliable on account of the gases evolved at the electrodes, which constantly varies the resistance, making them very inconstant in their action. Saline or acid solutions, when used as conductors, are very sensitive to slight changes in temperature and density. In Clark and Sabine's "Rules and Formulæ" are to be found the resistances and conductivities of those saline and acid solutions which are generally used. Such forms of regulators have neither stability nor portability.

In practice we find regulators which are made by using metallic conductors, and these conductors can be readily manufactured into resistances meeting all the requirements demanded of them in practical work where the regulation of the current is desired.

A number of methods have been tried by means of which a conductor could be used as a resistance at a very high temperature, or near its maximum efficiency. The wires or strips have been embedded in a non-conducting substance so that the wire can be used at a higher temperature than is permissible where the mechanical strength of the resistance wire is depended on in the construction of the regulator; the non-conductor in which the wires are embedded would have to be fireproof in order to use the wires at a high temperature. It has been found in practice that there are no real advantages in this method, for we would have to work the conductor under very disadvantageous conditions. Having prevented all possibility of the conductor cooling by convection, the only method left of dissipating its energy is by conduction and radiation through the surrounding non-conductor. Such cooling takes place so slowly that a

* From the Electrical World.

conductor carrying a current that would raise its temperature to 115 degrees Cent. when exposed to the air would in time be melted if it were embedded in a non-conducting substance, although its fusing point is about 1,800 degrees Cent.

Where stability of resistance is required this method is plainly out of the question, as may be seen from Table I., where it is shown that a conductor after

TABLE I.

Iron Wire. Temperature.	Resistance.	Copper Wire. Temperature.	Resistance.	Platinum wire. Temperature.	Resistance.
0° C.	640	0° C.	814	0° C.	1,870
21° C.	691	21° C.	864	21° C.	1,986
285° C.	1,660	Scarcely incandescent	2,100	Barely incandescent	4,300
Commencing to color	2,250	Carmine red	2,450	Red hot	4,700
Dark grey	2,460	Brick red	3,300	Light red	5,050
Scarcely incandescent	3,050	Bright red	4,700	Orange	5,400
Dark red	3,200	21° C.	910	Light yellow	6,000
Bright red	3,650			21° C.	1,984
Red hot	4,550				
White hot	4,880				
21° C.	727				

having been raised to a high temperature has its resistance materially changed.

It also may be noticed from this table that for each degree between zero and 21 degrees Cent., the average increase of resistance per degree is very small when compared with the increase between 21 degrees Cent. and 285 degrees. In the case of iron wire, for instance, the average increase per degree below 21 degrees Cent. is 0·39 of one per cent., whereas between 21 degrees Cent. and 285 degrees, the average increase per degree is 27 6-25 per cent.

It also takes considerable time for a resistance wire so confined to reach a constant temperature, and when placed in circuit the amperes continually fall until the point has been reached where the heat is conducted away as fast as it is formed. In experiments which were tried by the author on wires embedded in plaster of Paris and Portland cement, it was found that the silicates and sulphates from these substances combined with the wires at a high temperature and eventually destroyed them. The above are the main objections to the manufacture of resistance conductors inclosed in a non-conductor.

There are a number of ways in which resistance wires may be mounted; but the method most universally used is to wind the bare conductor in such lengths as required on a mandrel. The spiral is then slipped off and slightly stretched to separate the different convolutions. Evidently a conductor made up in this way cannot be used at any temperature that will sensibly affect its mechanical properties of elasticity or tensile strength. Moreover, at such high temperatures oxidation is more easily effected and the conductors more rapidly deteriorate from this cause. Metals brought a number of times to a high temperature and then allowed to cool, which is the practical condition when used as a variable resistance, gradually disintegrate and lose their fibrous or crystalline structure. This is especially noticeable in high resistance alloys. In addition to this the specific resistance of the conductor is increased by being raised to such high temperatures. These are the practical reasons why conductors cannot be used at more economical temperatures than the temperature they will be raised to by the current in amperes given for the different metals and diameters in Tables No. II., No. III. and No. IV. These tables have been figured from actual experiments made under practical conditions. In column No. 1 of each table is given the capacity in amperes of galvanized iron wire, tinned iron wire and German silver wire wound in spirals and mounted in wooden boxes, where fair ventilation is given. The current capacity of these wires is the maximum that should be allowed where wood or combustible material is used in construction.

A spiral loses its heat by convection much more rapidly in a horizontal than in a vertical position, and it will always be advantageous to design the resistance box so that when in use the spirals will be in a horizontal position. The box or frame in which these spirals are mounted should be open on the sides to admit free access of air.

In using columns No. 1 in Tables Nos. II., III., IV., the wires can be used at tne amperes capacity given, independent of the size of the box and the total number of watts lost in the regulator.

Columns No. 2 give the amperes that can be carried by these wires where fireproof construction is used. Columns No. 3 give the capacities that can be used for the special purpose of starting shunt-wound motors. The amperes given are the currents which the wires will stand for one minute, and as forty seconds is ample time to start a motor under full load, the factor of safety is such that the wires would be brought only to a very dull red if by accident the starting coils were left in circuit. These capacities are only to be used with fireproof construction.

In column No. 1, when the wire is mounted in a wooden box, with fair ventilation, the heat limit is found to be 39 degrees Cent. In column No. 2, with fireproof construction and with slate or porcelain used as an insulator, and with free access of air, the heat limit is 48 degrees Cent., the temperature of the surrounding air being 22 degrees Cent. In column No. 3 the temperature attained varies as the time during which the current is passing through the wire, the maximum being about 400 degrees Cent.

In the case of galvanized iron wire table, the Washburn & Moen gauge is used, and by this gauge this wire is most readily obtained in the market. The wires on which these resistances were figured is on what is known as grade B, one mill foot being equal to 92·6214 legal ohms at 15·50 degrees Cent. This wire has a resistance about 8 per cent. higher than the best grade of galvanized iron wire used in line construction. The resistance per cubic centimeter will vary from 1 to 1¼ per cent., depending upon the per cent. of carbon in the iron and the thoroughness with which the galvanizing has been done. At a temperature of about 18 degrees Cent. the resistance increases about 0·41 of one per cent. for each degree. If any greater degree of accuracy than 1¼ per cent. is required, a sample of the wire to be used in the construction of the resistance should be tested for its conductivity. Resistance in the tinned iron wire table was determined from ordinary tinned iron wire. The resistance of different samples may vary about 1½ per cent. from that given in the tables.

TABLE II.

GALVANIZED IRON WIRE, GRADE B.

Washburn & Moen wire Gauge.	D. Diameter in mills.	D². Circular mills.	I. Maximum safe current in ampéres in wood frames.	II Maximum safe current in ampéres in iron frames.	III. Maximum safe current for one minute.	Ohms per foot.	Feet per ohm.	Pounds per foot.
3	244	59,536	55	63.8	125	.00155	645	
4	225	50,625	48	55 6	110	.00182	549	
5	207	42,849	41	47.5	90	.00216	463	.1135
6	192	36,864	30	34.8	78	.00251	398	.0973
7	177	31,329	26	30.1	67	.00296	337	.0831
8	162	26,244	23	26.6	56	.00353	283	.0695
9	148	21,904	20	23.2	46	.00423	236	.0580
10	135	18,225	17	19.7	36	.00508	196	.0483
11	120	14,400	14.5	16.2	32	.00643	155	.0383
12	105	11,025	12	13.9	22	.00840	119	.0292
13	92	8,464	10	11.6	17	.01094	91.4	.0224
14	80	6,400	8	9.28	13	.01447	69.1	.0169
15	72	5,184	6	6.96	11	.01786	56.0	.0138
16	63	3,969	5	5.8	8.9	.02333	42.8	.0110
17	54	2,916	3.7	4.29	8	.03176	31.4	.00868

TABLE III.

TINNED IRON WIRE TABLES.

B. & S. gauge. No.	Mills D.	Cu. mills D².	I. Maximum safe current capacity. Wood frame.	II. Maximum safe current capacity. Iron frame.	III. Maximum safe current capacity for one minute.	Ohms per foot. Legal.	Feet per ohm.	Resistance in legal ohms per 100 feet.	Lbs. per foot.
8	128.4	16500	17.4	20.3	43.6	.00398	250.	.398	.040
9	114.4	13094	14.6	17.1	36 6	.00578	173	.578	.033
10	101.8	10381	12.3	14.3	30 8	.00728	137.	.748	.02751
11	90.74	8234	10.3	12.	25.8	.009177	108.	.878	.02182
12	80.80	6529	8 7	10.1	21.7	.011571	86.4	1.198	.0173
13	71.96	5178	7.3	8.5	18.3	.014588	68.5	1.473	.01372
14	64.08	4106	6.1	7.1	15.3	.018396	54.3	1.933	.01089
15	57.06	3256	5.1	6.	12.9	.023198	43.1	2.373	.00863
16	50.82	2582	4.3	5.	10.8	.029253	34.1	3.003	.00685
17	45.25	2048	3 6	4.2	9.1	.036883	27.1	3.843	.00543
18	40.30	1624	3.0	3.5	7.6	.046515	21.4	4.924	.00430
19	35.30	1252	2.52	2.9	6 3	.060319	16.5	6.124	.00341
20	31.96	1021	2.17	2.5	5.4	.073962	13.5	7.594	.00271
21	28.46	810	1.82	2.1	4.5	.09332	10.7	9.974	.00231
22	25.34	642	1.53	1 77	3.8	.11769	8.49	12.594	.001838
23	22.57	509	1.28	1.49	3.2	.148426	6.73	16.066	.001457
24	20.10	404	1.02	1.2	2.3	.187165	5.34	19.536	.001155

TABLE IV.

GERMAN SILVER WIRE.

B. & S. Gauge number.	D. Diameter in mills.	D² Circular mills.	I. Maximum safe current in ampéres.	Ohms per foot.	Feet per ohm.	Pounds per foot.
10	101.9	10381	8.5	.016640	60.9	.029658
11	90.7	8234	5.4	.020976	47.6	.023783
12	80.8	6529.9	4.6	.026448	37 8	.018860
13	72.0	5178.4	3.8	.033344	29 9	.014957
14	64.1	4106.8	3.2	.042048	23.7	.011859
15	57.1	3256.7	2.7	.053024	18.8	.009406
16	50.8	2582.9	2.3	.066864	14.9	.007456
17	45.3	2048.2	1.9	.084304	11.8	.005914
18	40.3	1624.3	1.65	.106320	9.40	.004693
19	35.3	1252.4	1.21	.137872	7.25	.003591
20	32.0	1021.5	.99	.169056	5.91	.002935
21	28 5	810.1	.88	.213168	4.69	.002327
22	25.3	642.7	.66	.268731	3.72	.001843
23	22.6	509.45	.55	.338960	2 95	.001463
24	20.1	404.01	.488	.427408	2 33	.001159
25	17.9	320.04	.434	.538944	1.85	.000921
26	15.9	254.01	.385	.679632	1 47	.000731
27	14.2	201.5	.343	.857008	1.16	.000669

It will be noticed in comparing the different tables that different wires carrying the same amperes have all about the same resistance per foot; there is a slight difference in favor of galvanized iron wire, which may be accounted for by the zinc covering radiating more readily than the bright surfaces of tinned iron and German silver wires.

The formulæ which agree most closely with the curve plotted between ampere carrying capacity and diameters in mills to bring the wires to the temperatures given were in column 1 $c = 0{\cdot}012d^{\frac{3}{2}}$, in column 2, $c = 0{\cdot}14d^{\frac{3}{2}}$, and in column 3, $c = 0{\cdot}031d^{\frac{3}{2}}$, and also in column 3 the heating effect on the wire will be found to correspond very closely with the specific heat of iron as given by Tyndall, that 2,000 foot pounds are required to raise one pound of iron from 0 to 100 degrees Cent. The high specific heat of iron is of great advantage in the case of starting shunt wound motors, as a large amount of energy disappears in raising this wire to a high temperature.

When the current carrying capacity of a wire is not considered, a wire of very small diameter can be used; then the metal whose resistance per cubic centimeter is the greatest is the cheapest resistance per ohm. When the ampere carrying capacity is taken into consideration all this is changed. For instance, in German silver, tinned iron wire and galvanized iron wire, the costs per pound bear to each other the ratio of 39, 8 and 4, but since the cost of a conductor is not merely the cost of the wire per pound, but when used as a resistance is the product of the weight, the cost, and the resistance per foot, with this in view the actual cost of the three metals used for resistance is reduced to the ratio of 20, 1·5 and 1. From the Tables I., II. and III. it can be seen that in figuring a resistance for any given drop the size of the regulator and the length of the wire used to give the required resistance will not vary with the metal of which the conductor is composed.

In the German silver wire table, I have only given figures representing the maximum amperes carrying capacity that would raise their temperature from 15·5 to 32 degrees Cent. This metal should only be used where very exact regulation is required, on account of its small change in resistance per degree of temperature, its high cost making its use in ordinary commercial work prohibitory.

Wires of smaller diameters than No. 22 B. & S. are not found, when wound in form of a spiral, to be stable enough when mounted to withstand the rough handling to which they are subjected in commercial work. With this in view German silver could be used in high resistance boxes with economy. Such cases could be readily determined by figuring the cost of wire in tinned iron and German silver necessary to make up the resistance required and comparing the cost of the two.

In Fig. No. 1 we have the curve between amperes

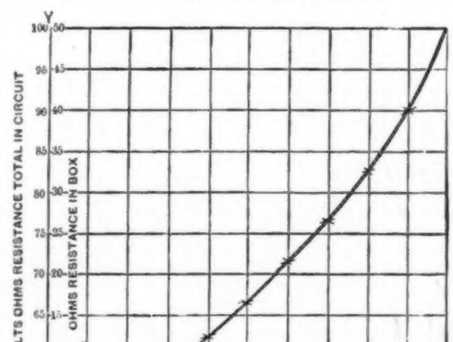


FIG. 1.—REGULATION CURVE BETWEEN VOLTS AND AMPERES.

and resistance which will give the least length of wire necessary to reduce the current from 2 to 1 ampere on a 100 volt circuit; this curve is the characteristic curve for any regulator figured for the maximum economy of

wire and space. The abscissa, O X, may be divided off into any number of equal parts, which would be determined by the closeness with which we wish to regulate the current. These would be the different points of contact with the resistance that the sliding contact makes connection with when increasing or decreasing the resistance in circuit, or the different points of contact could be so located as to give equal volts drop or equal watts lost on the successive steps. In this arrangement, the wires are connected in series, and advantage taken of the drop in the box to reduce the size of the conductors as the amperes they are required to carry decreases. The different points along the wire, which will be determined by the resistance required on the different steps, are connected to metallic blocks over which slides a contact to which is attached one pole of the circuit, the other pole of the circuit being taken to the contact block, which is also connected to the first end of the resistance having the largest ampere carrying capacity, and as the contact arm is moved away from the first contact block, more resistance is thrown in circuit.

Very often it is required to figure a resistance box that will adjust resistances to suit special conditions which will arise in the circuit to be controlled by a regulator; for instance in the case in which we wish to determine a regulator for a constant potential shunt wound dynamo, where we want to produce an increase of load proportional to the distance through which we move the contact arm. This can readily be determined from the field characteristic of the dynamo such as shown in Fig. 2; the abscissa, A X, can be divided off proportionally from no load to full load at a constant potential and the ordinates, A Y, laid off proportionally to the total resistance required in the shunt circuit, which will be the resistance of the field plus the additional resistance required to produce the amperes at the terminals of the dynamo. Several such points may be determined between the maximum resistance and no resistance. Laying off ordinates proportional to the resistance required in series with the field resistance, draw a curve through these points. If the line, NO, is divided off into a number of equal parts corresponding to the number of steps or contact points which we wish in the regulator, the ordinates from these points will be proportional to the resistance required on the different steps to give a regulator, which will give an increase of load directly proportional to the number of contact blocks in circuit. If the dynamo is kept at a constant potential, the line, AD, is the increase of resistance of the field on account of its heating. If the area between AD ON is small enough to be neglected in comparing with the area, AN OX, then the resistance box or a constant potential shunt wound dynamo could be used instead of an ampere meter by numbering the blocks consecutively; the output at the terminals of the dynamo will be the number of blocks out of circuit multiplied by a constant. Proceeding in the same way, a regulator can be figured to suit any required conditions.

There is another large class of regulators, such as equalizers, stage regulators and storage battery regulators, where, to accommodate the ampere capacity required, it will be found necessary to strand the resistance wires when we have to deal with large currents. Since the resistance per foot decreases as the amperes capacity increases, we soon find that the space and wire required to give a large current any considerable drop would make the regulator bulky, heavy and expensive, if the wires were connected in series. Methods of compounding or special combinations of the resistance wires can be resorted to with advantage. The expense incurred in constructing such mechanisms to distribute the current in various ways through the resistance wires will be offset by the decrease in the size and weight of the regulator or equalizer.

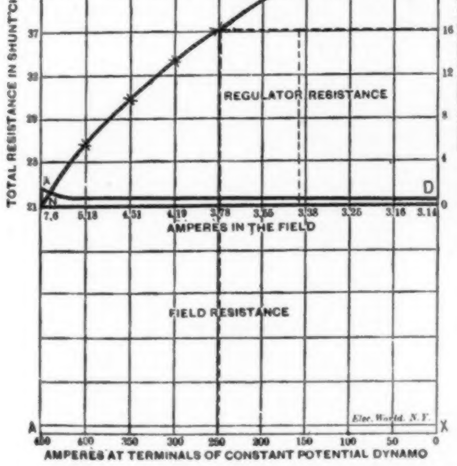


FIG. 2.—FIELD CHARACTERISTIC OF SHUNT DYNAMO.

A number of methods are used by different manufacturers; in Fig. 3 is illustrated the general method by which economy in wire is effected, by means of special switches to distribute the current through the resistance conductors. When the lever, A, is in the position shown in Fig. 3, the resistance coils are short circuited from the positive pole through the metallic bar, B, and then through lever, A, to the negative pole, when the lever, A, is withdrawn from contact. With bar, B, all the resistance coils are then in multiple are between the positive and negative poles. In this position we have the maximum ampere carrying capacity and the least resistance.

The resistance is increased by still further withdrawing the bar, A, when the coils, 1 and 2, will be cut out and the resistance of the regulator increased. The resistance can be still further increased by steps until lever, A, in succession, is withdrawn from all the contacts, when we will have only spiral No. 11 in circuit. The resistance may then be increased by withdrawing lever, B, and the spirals placed in series. By this arrangement we have obtained a regulator having the maximum ampere capacity on the first step, with all the spirals in multiple, and a maximum resistance on the last step, with all spirals in series; if the resistance of spiral 11 is so proportioned that it will not take more current than the maximum when lever, A, is removed, all the rest of the regulator will have ample capacity. This form of regulator can be figured to any curve by making the spirals of unequal resistances. Such a combination only gives 12 possible steps, but a more complicated switch could be designed which would multiple series the spirals, and which would give us a

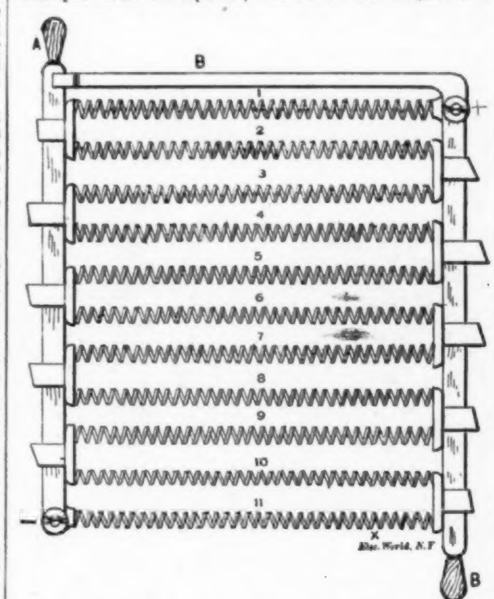


FIG. 3.—DIAGRAM OF RESISTANCE BOX

greater number of combinations with these spirals, so that any desired number of steps could be produced between the maximum ampere capacity and maximum resistance. In any regulator energy must be wasted to produce certain variations in the current. From the point of economy they are abominable, but they are as necessary to the electrician as the valve is to the engineer.

ECONOMICAL PRODUCTION OF POWER BY ELECTRICAL DRIVING.*

IN the able address of Prof. Kennedy before the Institution of Mechanical Engineers, the subject of economical production of power by electrical driving was very fully dealt with, and at the late meeting of the Iron and Steel Institute, at Brussels, a very interesting and instructive paper was given by Mr. Selby Bigge, which conclusively showed the importance and possibilities of the system. At the risk of rendering this address narrow, and more in the form of a paper, rather than general, I propose to give some illustrations of the applications of electrical driving, both in this country and abroad, hoping that a resume of what has actually been accomplished may promote a discussion which will thoroughly ventilate the question and be fruitful in beneficial results. With the late disastrous record of the shipbuilding and engineering industries, as an example, it is highly improbable that any capitalist will start a new shipyard among us, so that we may be sufficiently selfish to consider the application of electrical driving to existing works only. The first question to consider, therefore, is that having boilers grouped in one place from which steam is led to engines distributed over a large area, what economy can be expected from substituting those engines with electric motors supplied with power from a central station, and will the results justify the expenditure? We are all thoroughly aware that condensation does occur in steam pipes, and that the present engines are uneconomical, but a broad view is generally taken of the matter, and little has been done to ascertain what the results are. It is for this reason that the experiments and developments made by Mr. Panton, of Messrs. Dorman, Long & Co., of Middlesborough, in conjunction with Mr. Selby Bigge, are of the greatest value, and particularly so as they have resulted in complete success. The original steam-driven machinery comprised punching, shearing and bending machines, cold saws, etc., all which were distributed over a large area and driven by six engines capable of indicating the following powers, viz., 27, 14, 14, 14, 16 and 9. These engines were disconnected and replaced by motors of 10½, 3½, 5, 3½, 3½ and 3½ horse power respectively, the driving gear consisting of a belt from the motor direct to the flywheel of the machine. The most noticeable case is where a large bending machine formerly driven by an engine having a cylinder 10 in. diameter with a stroke of 12 in. is now efficiently worked by a 3½ horse power electric motor. The current for these motors is generated by a 50 horse power Pieper dynamo driven by an ordinary horizontal engine, the steam being obtained from two Lancashire boilers which were already in use in connection with the steam driving of another portion of the works. Formerly the six engines in question were supplied with steam by two boilers, which are now dismantled, with the result of a net saving of 30 tons of coal per week and the entire labor in connection with stoking and up keep.

Another striking advantage is that the speed of the motors being practically constant under all loads within their capacity, the machines driven by them are always running at the desired speed, and are therefore in a condition for producing the greatest possible amount of work. In reviewing this plant we have the advantage of ascertaining the approximate loss resulting from condensation in a long range of steam pipes, and the working of small high pressure engines under conditions usually found in iron works and shipyards. It will be apparent, however, that the generation of power at one center admits of an economy beyond this, viz., the use of a modern high pressure triple expansion condensing engine, with a consumption of 12 to 14 lb. of steam per I. H. P. per hour, instead of a consumption of from 40 to 60 lb., as frequently is the case at present. It is evident that the loss in such a case as that of Messrs. Dorman, Long & Co. may be termed a maximum, on account of the machines working in the open air, and the steam pipes led underground, but the results from ordinary cases of shop machinery are often sufficiently startling to warrant more attention being given to them than they usually receive. For purposes of comparison we will consider the results obtained from two works of about equal driving power, one having an electric installation and the other steam.

One of the most complete installations of electrical driving in the world as applied to large industrial establishments is that of the National Arms Factory at Liege, Belgium. Those works were built in the year 1889, and are of very large extent, employing 2,000 hands, the daily output of finished rifles being 250. Some idea of the system adopted and the value of machinery for economical and rapid production may be formed when it is considered that there are about 58 parts in a complete rifle and bayonet, involving in their production about 750 operations; yet so great has been the development of machine tools used in this manufacture that, of the 750 total operations, only 6 per cent. are performed by hand labor. Another feature is that a large percentage of the machines are automatic, and advantage is taken of this by placing several in the charge of one operative.

The whole of the machinery is driven by electric motors receiving their current from one central dynamo coupled direct to a Corliss condensing compound engine having two cylinders and indicating 500 horse power at 70 revolutions per minute, with a boiler pressure of 90 lb.

The auxiliary feed and condensing water is supplied by a pump driven by a 10 horse power motor, receiving its current from the main generating dynamo, and placed on the canal bank 2,840 feet distant and 117 feet below the level of the engine.

The water after being used in the condenser is discharged into a tank placed 40 feet high, from which it passes through finely perforated pipes in the form of spray into an open reservoir on the ground level, and by this means is reduced in temperature so as to be again available for condensing purposes.

The generating dynamo is placed between the high pressure and low pressure engines, and the armature being on the main shaft, acts as a flywheel. The armature, which is 16 feet in diameter, was constructed in place. The electro-magnets are twenty in number, and there are 40 pairs of brushes, 20 on each side. The capacity of the dynamo is 3,000 amperes at 125 volts, and the makers guaranteed an efficiency of 90 per cent.

The current from this powerful generator is distributed to about thirty-one motors, ranging from 3 to 50 horse power, placed in different sections of the works.

The machines used in the manufacture of rifles are necessarily of light design, consequently the motors are arranged to drive line shafting only, and although the total length of main shafting exceeds 4,000 feet, and the total length of belting is about eleven miles, there are no indirect main drives, a motor driving one line of shafting only, the object in view always being the reduction of loss by friction.

Each motor is provided with an ammeter, and as those in charge know the amount of power required to drive the machines when being worked to their desired capacity, any increase of that power at once indicates that there is a waste in friction, while any decrease indicates that the machines are not doing sufficient work; and when it is remembered that the revolutions of the motor are practically constant under all loads within their capacity, it is impossible to imagine an arrangement which so exactly fulfills the requirements of maximum economical production.

Compare this with the wasteful arrangements so common in shipyards and engine works, where engines, often already fully loaded, have to drive still another new tool, and the "make-the-best-of-it" policy of giving just a little later cut-off is adopted. The result generally is that the mean revolutions of the main shaft are not only decreased by any variation in load, but are, in addition, highly sensitive to the variations of steam pressure. This is, however, a diversion, and referring again to the Liege factory, there is also a 300 horse power Willans engine coupled direct to a dynamo, which generates the current necessary for frequent extensions.

It has been found by careful experiment that the consumption of steam in the Corliss engine is about 14 lb. per I. H. P. per hour, while the losses are 10 per cent. in engine friction, 10 per cent. in the dynamo, 2 per cent. in lines, and 15 per cent. in motors, or a total efficiency of 63 per cent. at the motor driving pulleys of the indicated power of the generating engine. The whole of the electric installation was made and fitted by the International Electrical Company, of Liege, from the designs and under the direct superintendence of Mr. H. Pieper, the managing director and electrician in chief of the company, and we have an ample testimony of the efficiency of the entire plant in the fact that, although the works have been running over three years and a half, there has not been one single stoppage of the main dynamo during working hours, and no accidents of any kind whatever.

Particulars such as these are always of general interest, but any radical change made in existing works involves a considerable outlay, and extreme care is necessary to be certain that such a change would be commercially successful.

An example of what may be termed ideal electrical

* Abstract of president's inaugural address, Northeast Coast Institution of Engineers and Shipbuilders, England.

driving is that of the Bedson Wire Company, of Middlesborough, where the installation is the most perfect and complete that has as yet been attempted in this country. Every process connected with the manufacture of wire is carried out by means of electricity, the wire drawing, galvanizing, spinning, and barb fencing machines, overhead and locomotive cranes, hydraulic pumps, induced draught fans, lathes, centrifugal pump, are all independently driven by electric motors. Owing to the entire absence of shafting and belting, the construction of the building is very light, and the convenience of the whole plant is most noticeable. The current is generated by a 600 horse power dynamo driven direct by a three crank triple condensing engine, with boiler of 160 lb. pressure. A special tunnel, 350 yards in length, has been constructed for the conveyance of the conductors, and branches are taken from these to the fifty motors, which vary from 5 to 40 horse power each. The lighting of the works is most complete, the greater part being carried out on the inverted arc principle, which is so perfect that there is an entire absence of shadows. The original plans for driving these works electrically were prepared by Mr. Selby Bigge, who appears to have given considerable attention to the question of electric driving. Before definitely deciding to put down such a novel plant several experiments were necessary, for which purpose special machines were designed by Mr. Bedson, the managing director of the Bedson Wire Company. These experiments were made at Liege by Mr. H. Pieper, and were so successful that after an exhaustive series of tests, the directors of the company decided to adopt the electrical installation in its entirety.

A novel feature in connection with the boilers at Messrs. Bedson's works is the application of Messrs. Ellis & Eaves' well known system of induced draught. This is the second application of the system to land boilers, the first having been made at the Atlas Works, Sheffield, originally arranged with Lancashire boilers. These have gradually been replaced by ten single ended boilers of the marine type, the advantages claimed being as follows:

1. Considerable economy compared with the Lancashire boilers with Galloway tubes.
2. Considerable reduction in space occupied.
3. Absence of smoke.
4. Greater elasticity of power.

In ordinary work, by maintaining a vacuum of 3 inches at the fan, the combustion is at the rate of about 35 lb. per square foot of grate surface, and one single ended boiler can readily evaporate as much steam as three Lancashire boilers 27 feet by 7 feet, with ordinary chimney draught. Where the demand for steam varies in a works, the system is a great convenience, and this is especially the case for electric light installations. It is evident that with this system of draught, or with any other efficient system, the assumed consumption of thirteen tons per day could be still further reduced.

From the comparison which I have made, we may fairly conclude that the saving gained by the substitution of electrical driving in an old established works would be considerable. Whether this saving would justify the outlay in all cases would have to be settled by those who have their capital invested in works suitable for its adoption. I may say, however, with reference to the firm of which I am a member, that for some time we have had the matter under consideration, and the various investigations and experiments made by Mr. D. B. Morison, and of which are those enumerated in this address, have so convinced us of the commercial possibilities of the system that we have now on order a small plant prior to further developments hereafter.

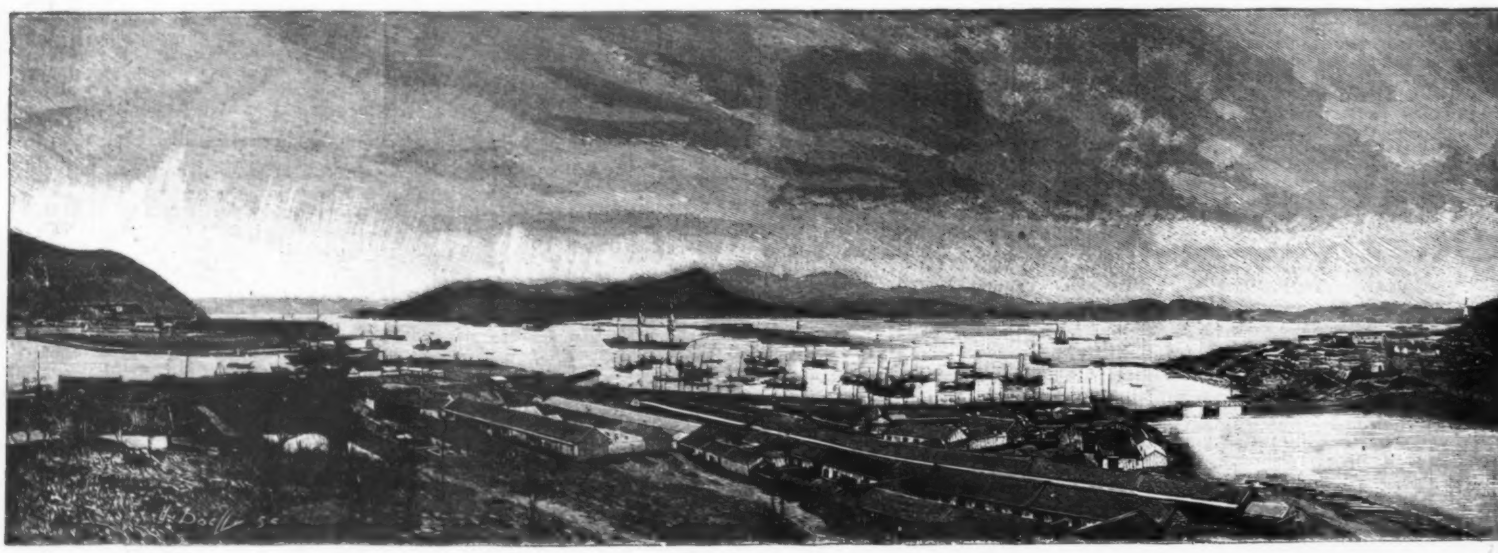
I have endeavored to confine myself in my remarks to a plain statement of what has been accomplished by making use of electrical power to drive machinery, and have not gone into any of the possibilities the future may reveal.

We have known the science of engineering to advance at times as it were by leaps and bounds, and from the rapid strides that this comparatively new energy has made within the last few years, we may have reasonable expectation of still further development in this direction.

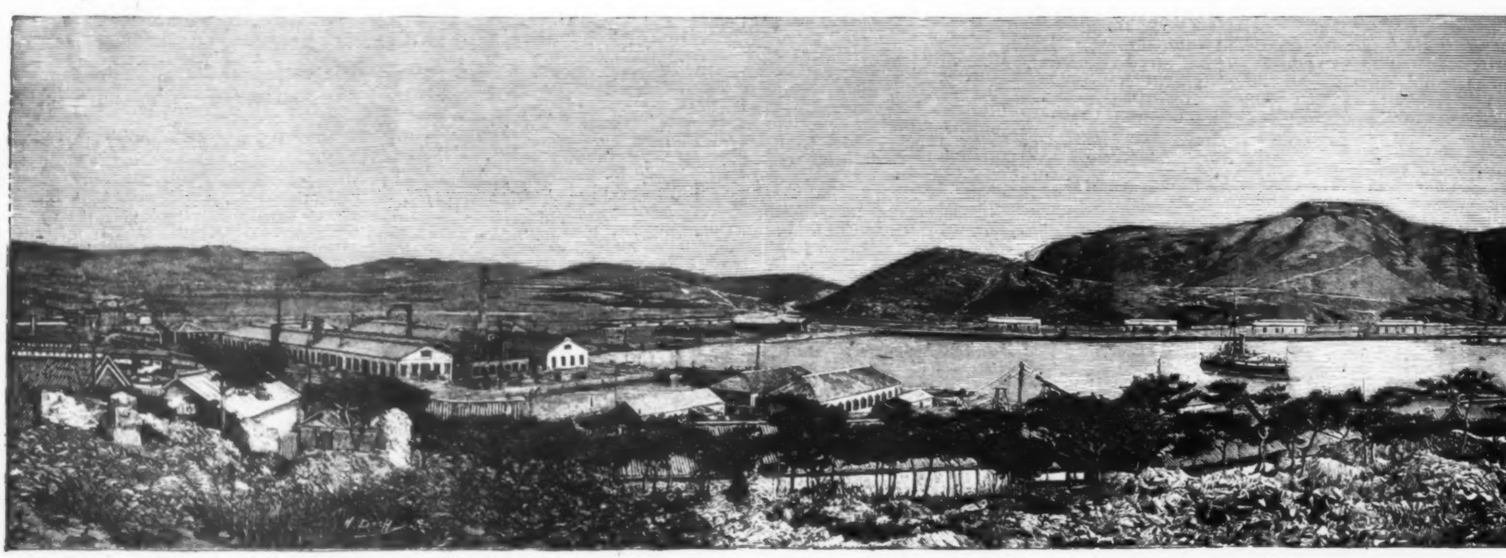
In the address which I have given you this evening, I feel that I have but inadequately fulfilled the task imposed when you conferred upon me the honor of electing me president of this valuable and widely known institution, but hope that my remarks will be productive of help in the work before us. That the suggestion of the possibility of further expenditure of capital is unpalatable to many members of this institution, I can well believe, seeing what dark clouds are hanging over us, but let us hope that, as in past times, the clouds will have a silver lining and shortly disperse, giving place to the pleasant sunshine of renewed commercial prosperity, of which both capital and labor will receive their just and fair proportion.

PORT ARTHUR.

DURING the diplomatic negotiations in which the mediation of England was solicited to obtain a peace, the efforts of the victorious Japanese were largely devoted to the investment and capture of Port Arthur, where the Chinese vessels sought a refuge after the great naval battle fought on the Corean shores. Port Arthur is situated near the end of the great promontory which shuts in the Gulf of Pe-Chi-Li on the north and with Chifu on the south commands the outlet of the gulf, which is here only two and one-half times the width of the English Channel from Dover to Calais. Port Arthur is a great naval arsenal, and is to China what Toulon is to France. The entrance to the harbor is by a channel only about six hundred feet wide. While there is no great space for anchoring vessels, there is a tidal basin capable of accommodating a dozen vessels at once. There are also a dry dock, machine shops, military and naval stores, as well as a coal depot. After the viceroy had examined the plans submitted by the French engineers, the contract was let and the works were executed in four years at a cost of about $1,500,000. At the right of the picture will be seen the small canal which connects the natural basin of Port Arthur with the Gulf of Pe-Chi-Li. On the right bank is the manufactory of torpedoes.



Battery. Entrance to new basin. Entrance to port. Torpedo works. West bay. Channel beacon tower.



Directors' establishment. East fort. Workshops. Pumping works. Battery. Battery. Cranes. Magazines of the war ships. South fort.

PORT ARTHUR, THE CHINESE NAVAL DEPOT AND STRONGHOLD.

The fortifications consist of thirteen batteries and cover about four miles of seaboard. These batteries are distributed on both sides of the channel. The sites of the batteries are excellent, and they are equipped with modern guns of European make. The armament consists of fifty 6 inch and 9 inch Krupp guns, in addition to mortars, howitzers and rapid fire guns. A submarine mine protects the channel and a fleet of torpedo boats is attached to the port. On the landward side is a series of small forts and earthworks. These forts are chiefly armed with rapid fire guns and mines. The garrison of Port Arthur, according to a dispatch from Yokohama to the Westminster Gazette, states that the number of Chinese troops at Port Arthur and Kin-Chow is (October 30) 13,000, of which 4,000 are raw recruits. A cablegram received from Minister Denby, of Pekin, by Secretary Gresham on October 31 states that the Japanese have taken one fort at Port Arthur, so that the early capitulation of this important strategic point may be looked for. The capture of Port Arthur is an important step toward the investment of Pekin. We are indebted for our engravings to Le Monde Illustré.

PERUVIAN TREPANNING.

By H. C. Hovey.

Trepanning has been practiced in Europe since the age of Pericles. The word, τρύπᾰνον, meaning literally an auger, was first used to describe a surgical instrument by Hippocrates. For centuries the tools and methods were rude and imperfect. With the introduction of modern appliances and improved methods the word trephining was employed as a substitute for the original term, trepanning; and the most accurate authorities recognize this distinction, using the latter for the primitive and the former for the perfected process. Thus one of the most eminent surgeons of New York City used to boast that he had successfully "trepanned" a patient with an ordinary mallet and chisel, because the emergency was such that he did not have time to send for his costly "trephine."

The American aborigines had some familiarity with the mysteries of surgery, as well as of medicine; and their modes of warfare would naturally lead them to seek ways of relieving the dangerous pressure on the brain following blows from spiked war-clubs and other crushing weapons. Their belief in demoniacal possessions would also induce them to seek for devices for liberating the evil spirits from the heads of the possessed. Epilepsy and paralysis were generally attributed by them to demons. Trepanning would thus be suggested to their wise men. In the Rust collection, now in the museum of Beloit College, is a Mexican terra cotta mask or image representing a paralytic whose features were drawn to one side, while the skull was trepanned on the opposite side as a means of relief. This specimen was undoubtedly antique. Others may have been found on our northern continent, although this happens to be the only one the writer has seen.

The ancient Peruvians, however, seem to have been adepts in surgery, as in everything else. They excelled in agriculture, mining, milling, weaving, and engineering. Their cyclopean ruins are marvels of architectural skill. Indeed, they surpassed, in many respects, their Spanish conquerors. Hence we are not surprised to be told that they included a knowledge of the art of trepanning among their accomplishments. Several single specimens have been sent from time to time to American and European museums.

The Muniz collection, exhibited at the World's Congress of Anthropology, and now in the custody of the Bureau of American Ethnology, is the most remarkable of its kind. The entire collection includes about one thousand skulls exhumed from the vicinity of Cuzco, Huarochiri, Tarma, Pachacamac and Canete. They belong to Senor Manuel Antonio Muniz, M.D., Surgeon-General of the Peruvian army, and will shortly be returned to the Peruvian museum at Lima. Nineteen of these skulls are especially interesting as showing the methods and results of primitive trepanning. I take pleasure in acknowledging my indebtedness to Prof. W. J. McGee, of the Bureau of Ethnology, for the privilege of examining this extraordinary collection, and for the accompanying photographs now first published, as well as for permission to avail myself of his accurate observations as to their indications and lessons.*

What first strikes our attention is the fact that no signs are seen of the use of metallic instruments, which agrees with the theory that this trepanning was prehistoric. In some instances the cranial incisions were narrow, long and straight, usually at right angles with each other (Figs. 1 and 8). The cutting was what might have been done by an arrow point held vertically and drawn backward and forward, making a groove deeper in the middle than at the extremities. In other cases the direction of the cutting was constantly changed, so as to saw out an elliptical piece from the skull, the rough tool marks being afterward scraped smooth (Fig. 2). In still other cases there appears to have been no cutting nor sawing, the entire process having been effected by scraping, and the opening thus made being circular (Fig. 3).

Occasionally the operation may have been post mortem, as in one skull where twenty distinct incisions are to be counted. If ante mortem, the individual certainly could not have survived such heroic treatment (Fig. 1). The supposition is that, in these cases, the purpose was not surgical, but was merely to obtain a bone button to be worn as a trophy or a charm.

Most of the nineteen trepanned skulls, however, show signs of a surgical or thaumaturgic purpose. There are indications of a subsequent sloughing of the bone, or else of reparative growth, either of which would prove the operation to have been ante mortem. The skull represented in Fig. 4 was thrice trepanned, the subject surviving two operations, but finding the third, which cut through two of the sutures, fatal. In several cases the partial or complete absorption of the plates and spongy substance between them is an evidence of the survival of the patient. In one skull (Fig. 5) the bone was plainly diseased, and suggests the possibility that the orifices were caused by decay, instead of artificially. In others the signs of previous cranial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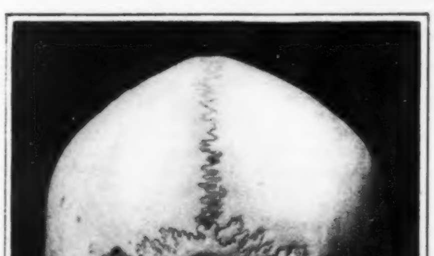
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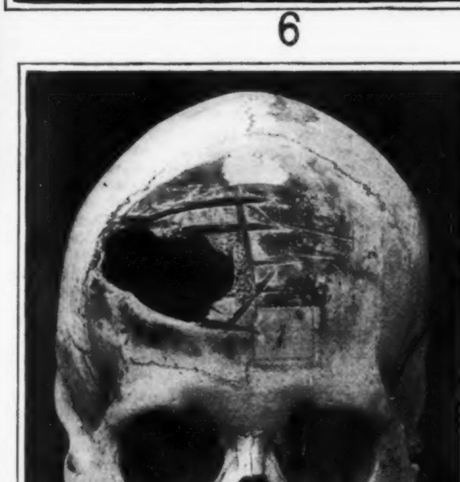
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TREPANNING AS PRACTICED BY THE ANCIENT PERUVIANS.

* See descriptive article by Prof. W. J. McGee, in the Johns Hopkins Hospital Bulletin, No. 37, Jan.—Feb., 1894.

fracture are evident. In the head of a mummy (see Fig. 6) the skull had been fractured by a blow, after which the scalp had been laid open and trepanning begun by three incisions, with the object of removing the broken part, but discontinued on account of the death of the patient.

Prof. McGee regards the remaining specimen I shall notice as being of exceptional interest in several ways (Fig. 7). The aperture is of remarkable size and the skull itself is small and thin. The individual was doubtless young and a female. A depression, not near the trepanning, probably by a blow received long before the operation, may have caused the diseased condition, possibly epilepsy, which demanded treatment. Successive operations to relieve this condition were made, which were united in the very large opening now visible, four inches long by more than one inch wide. This enormous aperture was covered by a silver plate found in the mummy case with the remains. The marks of its seat in the skull are distinctly visible, but the plate itself has not been sent to this country, being still in the possession of Dr. Muniz, who vouches for the facts. There is every indication that the patient long survived the series of operations performed, making this ancient Peruvian case worthy of being mentioned along with the historical record of the Count of Nassau's being trepanned twenty-seven times during King William's wars!

The results of modern trephining, with the improved instruments, are generally anything but encouraging. Promptness is demanded in beginning and great caution in proceeding; hence the opinion prevails that greater success attends private practice than those cases where there is delay in getting the patient to the hospital, and a subsequent expedition arising from the multiplied claims on the surgeon's attention.

According to Gross, trephining is nearly always fatal in the hospitals of Paris and Vienna. The proportion of recoveries in the hospitals of London, Dublin, Edinburgh, and other large cities of Great Britain is officially reported as only one in four cases. A similar report is made by the New York hospitals, where it is said that eleven in forty-five recover. This makes it remarkable that, in the Muniz collection, eight out of the nineteen individuals whose skulls were trepanned evidently survived one or more operations. Taken as a whole this unique collection is regarded by the Bureau of Ethnology as "by far the largest and most instructive assemblage of specimens of primitive trepanning thus far brought together, and as of special note in that it demonstrates certain points that have been heretofore obscure." It is not denied that the operations may have been partly thaumaturgic, i. e., for the expulsion of evil spirits; but the indications are that there was also a degree of intelligent surgery adapted to remedy cranial fractures, and also to relieve certain diseases of the brain.

[FROM THE LANCET.]

DR. VIQUERAT'S TREATMENT OF TUBERCULOSIS.

By ARTHUR GAMGEE, M.D. Edin., F.R.S.

THE sensational paragraphs which have appeared in various Continental journals, and which have been copied into the English papers, announcing the startling discovery of a new and certain method of treating phthisis and other tuberculous affections induced me to telegraph on Tuesday, September 19, to Dr. Viquerat, of Moudon, asking him whether he would be at home on the following day, as I wished to see him in reference to his treatment of tuberculosis. Receiving an affirmative reply, I left Lausanne by the 5:30 A. M. train, and shortly after 7 A. M. reached Moudon, a quaint mediæval little town, once the capital of the Canton de Vaud. I was received by Dr Viquerat with the greatest courtesy, and in my interview with him, which lasted until midday, he manifested the greatest readiness to acquaint me with his method, and frankly replied to every question which I put to him.

In the criticisms which I shall feel called upon to make, and the warning which I shall feel compelled to address, I must neither be understood to impugn Dr. Viquerat's good faith and veracity nor to cast a slur upon his scientific capacity and his professional devotion. It will, however, be my duty to draw attention to the weak links in the chain of evidence which Dr. Viquerat adduces, and to show, as I think, conclusively, that his method of treatment is yet in the strictly experimental, or rather tentative, stage, and that the evidence in its support is insufficient to justify the confident anticipations which have been indulged in. Instead of building castles in the air only destined to be dissipated, let the friends of phthisical patients in England await the calm judgment of those able to form a sound opinion when the necessary experimental and clinical evidence shall have been laid before them and the means afforded of adequately controlling Dr. Viquerat's assertions.

The experience of the error into which so great an observer as Koch fell, and the fact (which I am bound to refer to) that Dr. Viquerat's enthusiastic nature has led him, on one occasion at least, to announce a therapeutical discovery which has disappointed all expectations, not only justify but compel caution. Dr. Viquerat may rest assured that neither praise nor gratitude nor honors will be grudged him if he prove successful in his struggle with that disease which surpasses all others in the victims which it claims; on the other hand, in the interests of humanity, the leaders of scientific medicine have a right to claim that they shall be allowed to examine the minutest details of alleged medical discoveries before these are submitted to the popular suffrage.

The statements in this article which relate to the details of Dr. Viquerat's method of treatment and to his opinions are derived in part from a pamphlet lately published by him,* in part from a report † dated September 3, 1894, signed with the initials "G. P.," and of which the writer is a young medical man until recently a student in the University of Geneva, but mainly from information directly communicated to me by Dr. Viquerat in my interview of September 20.

Dr. Viquerat's method for the treatment of tuberculous diseases is based upon and suggested by principles and general methods which we owe in part to the great Pasteur and in part to two distinguished pupils of Koch, Behring and Kitasato. Pasteur had shown that animals could be rendered immune from the attacks of certain virulent infective diseases, such as chicken cholera and anthrax, by inoculating them with successively increasing doses of attenuated cultures of the bacteria which occasion them. It was afterward found that protective immunity could likewise be secured by injecting cultures sterilized by heat or cultures which had been freed from all bacteria by filtration through unglazed earthenware Such sterilized or filtered cultures owe their immunizing properties to soluble chemical substances which are produced by the pathogenic bacteria, and which, when introduced in sufficiently large quantities into the animal organism, induce all the phenomena of the special bacterial disease. Thus immunity against tetanus or against diphtheria can be induced by repeated subcutaneous injections of gradually increasing quantities of the soluble toxic substances which are formed by the tetanus and diphtheria bacilli respectively. It is, however, to Behring and Kitasato that we owe the conception and the actual method for the treatment of bacterial diseases by means of the serum of immune animals, and it is they who may be said to have introduced "serum therapeutics." They showed in 1890 that when the blood serum of rabbits which had been rendered immune from tetanus was repeatedly injected subcutaneously into mice, these creatures, which are peculiarly susceptible to the tetanus poison, were in their turn rendered immune, so as to be ultimately unaffected by the injection of the most virulent cultures of the tetanus bacillus or the strongest solution of its poisonous products.

They found, moreover, that the serum of an immunized animal when mixed, outside the body, with a virulent culture or a toxic solution of its soluble products destroyed their power of inducing the phenomena of tetanus. Further, they discovered that the serum of animals rendered immune from tetanus when repeatedly introduced into the body of others already suffering from the disease caused the symptoms to abate and often led to recovery. These beautiful and wonderful discoveries led, in the first instance, to a rational method of treating tetanus as affecting man which in the hands of Tizzoni, Javel and others, has enabled them to save many lives which would otherwise have certainly been sacrificed.

The same method applied by Behring to diphtheria has led to the treatment of this disease by the serum of horses rendered immune from diphtheria—the treatment which, as carried out by Dr. Roux, the distinguished chef de service of the Pasteur Institute in Paris, has reduced the mortality from 63 per cent. of all treated (the proportion of deaths in the cases occurring in a hospital when the old treatment was at the same time being carried out) to 26 per cent., and, as carried out in Berlin, has reduced the mortality from 41 to 15 per cent. of all cases treated (Aronson). If one considers that a large number of the 300 cases treated in Paris and the 274 cases treated in Berlin were in the last stages of the disease, and that in many the gravest complications existed, it cannot be doubted that when the treatment of diphtheria can be undertaken in its early stages the results will be still more remarkable, and that this dreaded disease will, through the beneficent researches of science, have been deprived in great measure of its power of evil.

Inasmuch as pulmonary phthisis and other tuberculous affections are the result of the activity of a pathogenic micro-organism, the tubercle bacillus of Koch, it occurred to Dr. Viquerat to employ in this treatment the serum of animals immune from tubercle, and in the first place to endeavor to find some animal easily available to man which possesses a natural immunity from tubercle. It has been shown how artificial immunity from the inroads of pathogenic bacteria may be secured, and a few words must now be devoted to natural immunity.

There exists a natural immunity, relative or absolute, which explains why certain individuals readily fall a prey to specific bacterial diseases, such as the infective and contagious diseases, while others escape scatheless who are placed under precisely the same conditions. There are instances of natural immunity possessed by certain of the lower animals which are very remarkable. Thus the common rat possesses almost complete natural immunity from anthrax, while the white rat is readily affected by it. In his inquiries Dr. Viquerat discovered that the only domestic animals which under the normal conditions of their existence have never been observed to become tuberculous are the ass and the mule. Even the horse, as the writer learns from a letter received from Dr. Guillebeau, the eminent professor of pathology in the Veterinary School of Berne, is so rarely the subject of tuberculous affections as to have been long held to possess a natural immunity from such diseases; its absolute immunity has in recent times been disproved.

In the articles which have appeared on the subject of the Viquerat treatment the statement is made that it consists in the injection of the serum of asses' blood into the body of the person or animal affected; and in the pamphlet published by Dr. Viquerat, as well as in the report already referred to, allusion is only made to asses' serum without any mention of the animal yielding the serum having been subject to inoculation with tubercle. Dr. Viquerat, however, brought before the writer facts which prove that the immunity enjoyed by the ass is not an absolute one, and informed him that, in order to strengthen the natural immunity, he subjects the ass or mule which is to yield the immunizing serum to inoculation with cultures of the tubercle bacillus.

The ass and the mule, according to Dr. Viquerat, though never becoming subject to tubercle under ordinary conditions and offering a far greater resistance than the horse, do not enjoy an absolute immunity under certain experimental conditions, though he asserts that in the case of these animals the tuberculous affection which is artificially induced invariably terminates in recovery. The natural immunity of the animal, he asserts, is re-enforced by the temporary disease, so that its blood serum introduced into the body of other animals possesses the power of arresting the progress of tuberculous affections and (if these are uncomplicated) of curing them. The actual process employed by Dr. Viquerat in order to prepare the ass or mule which is to yield the serum for the treatment of tuberculous affections is as follows: 30 c. c. of an active bouillon culture of the tubercle bacillus are injected subcutaneously, and, immediately before or afterward, 15 c. c. of the same culture are injected into the blood stream through one of the jugular veins. He asserts that subsequently the ass or mule exhibits no rise in temperature or other symptoms of disease, and that the only objective phenomenon is a remarkably voracious appetite.

As the animal, according to Dr. Viquerat, invariably survives, no evidence of any tuberculous infection following the inoculation would be available had he not killed a series of donkeys at varying periods subsequent to the operation. As a result of these observations, he asserts that if an ass or mule, treated as above described, be killed between the fifteenth and thirtieth day after inoculation, the lungs are found to be pervaded by miliary tubercles which are never surrounded by hyperæmic lung tissue. If the animal be killed between the thirtieth and fortieth day, Dr. Viquerat asserts that the tubercles are found to be disappearing, leaving no trace behind them, while after the fortieth day the lungs are always found to have returned to a condition of perfect health. It is from the forty-fifth day, when spontaneous cure has already been more than completed, that the animal is used to supply the curative serum. With this object it is bled, and the blood is allowed to stand over ice so as to allow it to clot and to permit of the separation of serum. To this serum from 0·5 to 0·75 per cent. of carbolic acid is added, and it is then stored in stoppered bottles until required for use. Without wishing to be hypercritical, I must point out that the above statements are of so remarkable and withal of so improbable a character, that they cannot be accepted until the most complete and detailed record of each experiment is published, and until the results are confirmed by independent observers.

The number of observations would have to be very large in order to establish the fact that the ass or mule is after inoculation into the blood invariably affected by an acute miliary tuberculosis of the lungs—a miliary tuberculosis always terminating in recovery. It may very reasonably be objected that, unless the chances of error were minimized by such a number of experiments as the costliness of the animal experimented upon almost precluded, the probability is that the asses which when killed exhibited pulmonary tuberculosis would in the natural course have succumbed, while those which when killed exhibited no tubercle had probably remained uninfected.

A further criticism which will suggest itself to all who are conversant with experimental bacteriology is that, while Dr. Viquerat has followed up to a certain point the method of Pasteur, of Behring, of Kitasato and others, of inducing immunity against a bacterial disease by inoculation of the bacteria which induce it, his method is altogether exceptional, as he satisfies himself with a single inoculation and furnishes no proof that he has thereby induced absolute artificial immunity. But "enough of these pedantic objections" may be the remark of the enthusiast, only too anxious that Dr. Viquerat's predictions should be immediately accepted. "What are the facts on the strength of which Dr. Viquerat relies?" The first and, as it appears to me, the most promising of all the statements which Dr. Viquerat communicated to me was the following: that when the immunized serum of the ass or mule is injected every second day into guinea pigs which have been fifteen days previously rendered tuberculous by the inoculation of active tubercle cultures, the tuberculous glands which had become enlarged and perceptible rapidly become smaller and disappear, while the animal, instead of dying fourteen or fifteen weeks after the inoculation, regains perfect health.

If the observations made by Dr. Viquerat on this point be accurate, it appears to me that they offer the surest promise that sooner or later tuberculous diseases will yield to the treatment by the serum of animals rendered perfectly immune in respect of tubercle. But it is on the results which he has obtained in the treatment of tuberculous diseases affecting man that Dr. Viquerat in great part relies. Since February he has treated twenty five cases, among which are many diagnosed as cases of pulmonary phthisis in its earlier and later stages, as well as others representing various forms of surgical disease alleged to be of a tuberculous nature, no proof whatever being given of the fact. His usual plan is to inject 12 c. c. of the prepared serum every third day. I saw two patients thus injected, and I can vouch for the fact that in neither of these had the numerous injections to which they had previously been subjected led to any local accident—such, for instance, as suppuration.

All the information which is furnished in regard to the twenty five cases of alleged tuberculous affections treated up to the present time by Dr. Viquerat is contained in the so-called "report," to which allusion has already been made. This "report"* furnishes the most unsatisfactory and disappointing evidence which can be adduced in support of Dr. Viquerat's statements, and the amusing tone of authority assumed by its author is no less remarkable than the looseness of nearly every statement which it contains. Before criticising the list of cases given in this so called report it must be stated that at the foot of the document is printed the following announcement: "Sur la vue de ce rapport medical un Institut vient d'etre cree a la Cote-Drize a Geneve, dans lequel M. le Dr. Viquerat continue ses travaux de recherche et ou une clinique s'ouvrira le Nov. 1er, 1894. Les tuberculeux seront traites a l'Institut Viquerat dans l'ordre de leur inscription." Seeing the importance which, according to the paragraph just quoted, appears to have been ascribed to this so-called report, it would have seemed reasonable not to conceal the identity of its author, and to have furnished proofs, which are doubtless forthcoming, that he has now ceased to be in statu pupillari, and that his report may therefore be properly termed a medical report.

But to return to the twenty-five cases of supposed tuberculous affections referred to in the report: I must point out that no conclusions whatever can be drawn

* Das Heilverfahren der Tuberculose gegrundet auf bacteriologisch-experimentelle Studien. Von Dr. Viquerat in Moudon. Erste Auflage. Moudon Buchdruckerei. J. Kretz-Bettemann. 1894

† Rapport sur les Resultats obtenus par M. le Dr. A. Viquerat dans son Traitement de la Tuberculose (Geneve, le 3 Sept., 1894). Imp. Romet, Boulevard de Plainpalais, 26.

* The Lancet, September 29, 1894.

from the results of the treatment of the surgical cases which are diagnosed as tuberculous in character, as no grounds are given which permit of the accuracy or the diagnosis being tested. Hospital surgeons will share the skepticism of the writer in reference to cases reported as follows:

"Case 10.—R., Moudon, multiple cold abscesses, osseous tuberculosis, fistulæ. Improved; still under treatment."

"Case 11.—L., Ermanche, tuberculosis of the radius, fistula closed. Pains ceased, improved; still under treatment."

"Case 12.—C., Lucens, tuberculosis of the ulna, cold abscess of the neck. Cured."

Turning now to the cases diagnosed as pulmonary phthisis, it is found that they number 15 out of the total 25. Of the phthisical, 8 are stated to have been in the first and second stages of the disease and 7 in the third stage—i. e., cavities existed in the lungs; in 2 of these 7 cases laryngeal tuberculosis existed. Of the cases in the first and second stages, the majority are stated to have recovered, but, inasmuch as in these again no details whatever are given, one is compelled to be skeptical. The value to be attached to a diagnosis of phthisis in the first and even the second stage must depend entirely on knowledge of the skill and habitual accuracy of the physician who has made the diagnosis; great, however, must be the faith of the physician who would accept such notes of a case as the following:

"Case 22.—M. G., Penay, pulmonary tuberculosis, first and beginning of second stage. Cured."

"Case 23.—P., Chesal pulmonary tuberculosis, second stage; improved; still under treatment."

Passing now to the seven cases of phthisis in the third stage—that is to say, in which the disease had progressed to the formation of cavities—one is said to have recovered. The following are the notes of this case

"Case 2.—M. E. C., Moulin de Penay; pulmonary tuberculosis, second and third stage; acute form (forme galopante). Cured."

Is one to suppose that the cavity or cavities have disappeared in the few months which at most have elapsed since this case was treated, or that by "cured" are understood cessation of morbid symptoms and apparent return to health? Unfortunately, the physician knows that even under such circumstances one dare not speak, after only a few months of respite, of a case of advanced phthisis being cured. Excluding this one case, of the remaining six cases of phthisis in the third stage one (No. 9) ceased the treatment and died; one (No. 24) became affected with pulmonary gangrene and stopped the treatment; one (No. 25) has not improved, but is still under treatment; and three are said to have improved somewhat, but to be still under treatment.

The above short analysis of the cases which have as yet been treated by Dr. Viquerat's method justifies the opinion, which I expressed at the commencement of this article, that this method of treatment is yet in a strictly experimental or rather tentative stage, and that the evidence in its support is insufficient to justify the confident anticipations which have been indulged regarding it.

Notwithstanding the criticisms which I have felt compelled to make, I would, in conclusion, state that it appears to me that Dr. Viquerat is engaged in the study of facts which promise to lead to results of the greatest practical value, but only on condition that he does not unwittingly deceive himself and others by supposing that the discovery of the method of curing tuberculous affections is already an accomplished fact.

ALCOHOL AND HAPPINESS.*

By Dr. JUSTUS GAULE, of the University of Zurich.

NOT as an ascetic, Dr. Gaule assures his hearers, anxious to debar them from a pleasure, but from their own standpoint, as friend with friends, all interested in increasing the sum of happiness, he wishes to discuss the proposed question. First, where do all the life activities come from? They are, as it were, latent in the body substance, the expression in some form or other of impressions received from without. Every act, of course, destroys substance, which must be replaced. Material taken from outside does this work of rebuilding, and it is of two sorts—one, which is enough like body substance to be readily changed into it and express the same activities; the other, so unlike that, if it once finds way into the body in such form as to express its own latent power, it injures or destroys—is poison.

Alcohol belongs to the second class. That it injures can be readily seen in the liver, kidneys and stomach of a drunkard, and also in more delicate changes of the elements revealed by a microscope, where the quantity taken has been even a small one. A physiological examination proves always beyond a doubt that, where any appreciable quantity of alcohol has been taken, there are changes in the body substance, not always indeed wholly proportionate to the quantity taken, because the living elements have always more or less power to resist and overcome.

But I am not to deal with dangers and consequences from the use of alcohol, but with the problem of possible pleasure in existence without it. Let us see what pleasure does come from its use. While the influence of alcohol on the elements of the body is so evident and important, it is yet only as that influence touches the nerves that we are conscious of it. This becomes real to us in two ways: first, through the senses of taste and smell as it touches the outward body; and secondly when it has entered into the blood and begins its chemical working in the nerve centers. How far shall we count these influences pleasurable? We are wont to count them one, but in a physiological sense they are very different, resulting from the action of very different parts of the drink taken. Wine, for instance, is made up of six elements, five of which give the taste, the sixth the fragrance of the wine. One of the five is alcohol, the only one which cannot be enjoyed alone, and is never taken alone except by the man whose sense of taste has been utterly destroyed. We are not now situated as were the ancients—"der gute Noah," for instance—nor even as the men of the last generation, who had discovered so little of the earth's power to produce pleasure-giving substances that they were naturally delighted with and disposed to make the most of the new discovery of wine. We can take the elements of wine which do please our taste and make a better drink without alcohol. It needs only that a sufficient number of men resolve upon such a course.

But the effect of wine upon the brain and other nerve centers is that of the alcohol alone. To understand it physiologically one must remember the ordinary action of the nerves. An impression from without meets us, the nerves carry it to the nerve center, and a movement or other expression results. The movement does not, however, always accompany the sensation directly. In reading, for instance, one may indefinitely postpone any expression of received impressions; and then a single action may express a number of stored-up impressions, or again, one impression may call forth a number of movements. Man has learned to in some sense measure the relation of movement to sensation—as to rapidity of movement and as to the relative strength of the two. It is found, first, that the sharpness and certainty of sensations are modified by even small doses of alcohol, completely deadened or destroyed by large quantities. Secondly, as to the expression of sensation in motion, small doses of alcohol increase the quickness of that expression. Large doses make it slower and more slow, until at last there is no expression. Thirdly, as to the movements themselves, small doses make them more rapid but less sure of attaining the end sought; large doses tend to make movements impossible. And popular experience bears witness to the truth of these three statements, only the masses cannot understand how the rapidity with which action follows impression and rapidity of action itself are increased by small doses, but decreased by larger quantities; and the friends of alcohol have claimed that the difference between small and large doses is real, not of degree, and really distinguishes the moderation of the wise man from the madness of the foolish. But science has proved that this contradiction is only apparent. The same increased rapidity of expression of a sensation is noticed when the brain is stupefied, and the greatest rapidity results when the brain is entirely separated from the other centers. Reflex action is more sudden and more rapid than brain action. So the influence of alcohol is exactly as if the brain were cut away. The man no longer stops to consider the whole situation, to make use of impressions of former experiences stored away in his brain, or weigh present obligations, and the sly saloon keeper well understands this. The man who would engage another in a brawl or cajole a secret from him knows well how alcohol dethrones reason and loosens the tongue. And as more and more is taken, the stupefying influence reaches lower and lower, until at last even reflex action is imperfect and slow.

If this then is the influence, where is the pleasure in it? It is not my object, however, to depict the dangers and consequences from such disturbance of brain functions, but to ask only in what then consists the pleasure which alcohol brings us? The fact that so many men seek this condition, even passionately seek and value and prefer it to others, must have deep psychological ground. I will only say in passing that men differ as to the particular time of richest delight, some choosing the very beginning, others the time when sleepiness and forgetfulness have come, still others the perfectly senseless condition; but the influence of alcohol is still the same, sometimes on a smaller, sometimes on a larger portion of the nervous system. How does it increase the feeling of happiness? The body uses its powers in resisting the outside forces which act upon it. Normally, there is a balance between body and environment. If environment prevails, we are discouraged; if we are able to prevail, our spirits rise and our happiness grows. And it is not for the moment only, but we compare the accumulated impressions of the powers outside of us with the powers which our brains develop, and are happy or unhappy according as we feel our superiority or otherwise. Just how much does alcohol interfere in this balance of powers? It clearly cannot lessen the power of outside influences which harm us; it can as clearly not increase our own powers in so far as they enter into this conflict with the outside world—it rather makes us less skillful and able. What can it do, then? It can deceive us. It dulls our appreciation of powers outside of us until they seem so much smaller that we are sure we can conquer them, and so we gain a feeling of satisfaction. Nine-tenths of those who take strong drink seek this feeling in alcohol. This is their "refreshing" at eventide, their "rest from the day's cares," their forgetfulness of sorrows; but it rests upon a deceit, and at the least trial falls into ruin. He who to-day forgets is not any stronger to-morrow, and so is constantly tempted to a new appeal to his false friend, until his senses are so dulled that every duty is forgotten. His holiest interests are but shadows and mist before his eyes, and he knows nothing more but thirst for the deceitful drink. Even the defenders of alcohol at last call a halt; but they have forgotten that the first steps are much more easily undone than the later ones, when the brain has, in a measure, lost its power to control. They do not forget through malice, but because they have not rightly understood the physiological effect of alcohol.

And the poor drinkers say: "There is so much misery in the world, and we must have now and then a care-free hour; therefore we drink. What will you give us in place of drink?" Is the argument true? Is the future of mankind really so hopeless, and does life offer nothing to the man who refuses alcohol instead of the forgetfulness which alcohol brings? I believe that in this respect the attitude of men toward this problem has very much changed. Has not the newly awakened appreciation of nature in this century revealed a new source of joy which our forefathers did not know? Who ever could have known formerly that a glimpse of the Alps or the raging sea could give pleasure which really makes strong and furnishes recompense for trouble and trials? Our new insight into the secrets of nature, the general dissemination of art so that even the masses may enjoy its works, these are worth more to alleviate care than anything known of old. But it comes so slowly, some say. It takes the masses so long to acquire the power to appreciate these things. But why? Because they spend their leisure hours in seeking the stupor and forgetfulness which alcohol brings, and so have no time to discover beauty anywhere; also because so many have dulled their senses until they have no power to appreciate, and because alcohol has really made the sum of misery larger. That this is true is conclusively proved in communities where alcohol is not used at all. In Massachusetts, for instance, the most enlightened State of North America, where the question has been discussed pro and con, and the friends of alcohol have been worsted, the condition of the working class proves my statement. On a visit there I went through one of the cloth factories and was surprised when the foreman told me a certain workman wished to talk with me because he had learned I knew about microscopes. He wished to know what microscope was most in favor in Germany. I described a good one of moderate price—twenty dollars; but he said he had one of that sort and wished now a better one. On questioning him I found he really had knowledge about bacteria, for the study of which he wished his instrument; that he was president of a club of workmen who spent their leisure hours in this study. When I then looked at the homes of these workmen, with their pretty, well tended gardens and blooming, well dressed children, I felt clearly the different atmosphere where the father spends his spare time and money not for alcohol, but for the beautifying of his home. And can this life be less enjoyable than ours?

In Mr. Bryce's "American Commonwealth" he has devoted one chapter to the consideration of the pleasant character of American life, in which he calls attention to the general air of hopefulness which prevails among American people and extends also to all foreigners who visit them, through which, moreover, difficulties are lightly overcome, losses and injuries good naturedly endured. One misses this characteristic painfully among us when one has once experienced it; it is like a new melody in the great concert of life.

And what says this melody? I understood it first as I saw this hopeful spirit, and I said to myself, Must mankind, then, be always miserable? Must they be always helpless against Nature's forces? Can they not conquer these forces, make them subservient, if they use intelligence to understand them instead of stupefying themselves? Must they pine away for lack of pleasure in a world which is so beautiful that it charms us if we lift but the corner of the veil which hides its secrets? This it is which makes me consider life without alcohol more beautiful than the other, and that is the transformation in the feeling of mankind which I await with their development.

Nothing retards this development except that we are bound by the customs of the middle ages. The conditions of the middle ages have vanished, but the habit of stupor still remains, as if, in place of the serfs and lords of old, a new man had not come who can use his manly powers. See what this inheritance of inactivity costs us. Statistics of last year show that in Switzer land every tenth man who died, died directly or indirectly from drink; that of men between forty and fifty-nine years old every sixth was killed by alcohol. You have learned how our hospitals for the insane are filled and how men are led to violence from Dr. Speyr's lecture, and you recall scenes of coarseness you have yourselves seen as the result of alcohol. You will see that a chain of coarseness is drawn about our whole life, which binds us fast on a plane of barbarity and wretchedness. Follow this chain even to yourselves. It is wound about you. . . . That here one dies of delirium tremens, there one loses his senses through alcohol, there a deed of violence is done, here a brutality perpetrated—these are all manifestations of a single great phenomenon, the bondage of mankind to a plane of rudeness in which they deaden and make useless the most precious instrument which is given them for their development; and you are sharers in the guilt so long as you do not break this chain, so long as you do not have courage to adjust your life compass with reference to the future instead of the past.

This is the joy of the one who does not drink—the feeling of freedom from responsibility for misery, the joy of hope for the future of mankind, the increased sensitiveness to the beauty of the world; and on us, the chosen people, rest the hopes of the world for the future. We must be leaders.

* Synopsis of a lecture given in Berne, the second in a series for the advancement of temperance in Switzerland.—Popular Science Monthly.

SAMUEL HAHNEMANN.*

By H. P. HOLMES, M.D., Omaha, Neb.

IN the district of Chursachsen, one of the most beautiful and picturesque regions of Germany, and in the village of Meissen, lived an industrious, God-fearing German, by name Christian Gottfried Hahnemann, by trade a painter on porcelain. Here, with his wife, whose maiden name was Johanna Chrintiane Spiess, who was esteemed a most exemplary woman, he worked for the maintenance of his family, and ever strived to serve God and his fellow-men. "He had sound and original ideas on what should be called good and worthy in men, and his doctrine was to do and to be without striving after mere appearances." "Wherever an opportunity offered for doing good, there he was sure to be, helping heart and hand, and often unnoticed." He was the author of a small work on water color painting.

On the 10th of April, 1755, the hearts of this German couple were gladdened by Heaven's priceless gift of their first-born—a boy—in whom the interest of this lecture centers—a boy on whose head rested greater possibilities than on that of any child born to mortal parents, and who was destined to sway the thoughts of the world in the common interests of humanity for centuries to come. This child, born without the stars heralding his coming, was christened by his parents Samuel Christian Frederick Hahnemann.

The boy was the idol of his father's heart, and he inherited all those noble qualities which had made his parent the respected citizen of Meissen. Born in a region of strikingly beautiful scenery and with a natural love for the beauties of Nature's handiwork, Samuel became at an early age an ardent admirer of the works

* Delivered before the Alumni Association of Hahnemann Medical College, of Chicago, in March, 1892; before the faculty and students of Hering Medical College of Chicago, in March, 1893, and before the Missouri Institute of Homeopathy, at Kansas City, in April, 1893.—The Homeopathic Physician.

of the Creator, and this love for his Almighty Father constantly increased as he grew older.

The father and mother easily taught Samuel to read and write. At the age of eight years he was placed in the stadt (or common) school, and at the age of sixteen he entered the furstenschule. He became the favorite pupil of the principal, Magister Muller, and he made such progress in his studies that at the age of twelve years he was commissioned by the principal to teach to others the rudiments of the Greek language. Hahnemann, in speaking of his teacher, Magister Muller, says: "He loved me as his own child, and left me to enjoy liberties in the method of my study, for which I still feel grateful to him, and which visibly influenced my subsequent labors. During the private lessons which he gave to his boarders and to myself he would listen kindly to remonstrances on my part bearing on the interpretation of classic authors, and often accepted my translation in preference to his own. I had admission to him at all hours of the day, and I was often, in many respects, openly given preference to others. It is remarkable, however, that I had the affection of all my fellow-students nevertheless. All this in consideration receives greater importance when we remember that it happened at a furstenschule in Saxony. While here I took pains to read less, and to thoroughly grasp in my mind before reading further."

With a family which rapidly increased to ten children, the father was not able to give them the education he desired, and he often took Samuel away from the stadtschule for years together, and stoutly opposed his son's taking a college course, or even continuing very long at the furstenschule. It is related that at one time he forbade Samuel using the family lamp for his studies after the rest of the family had retired. But the boy, nothing daunted, fashioned a lamp out of a lump of clay, successfully coaxed his mother for oil, and in secret did the studying his boyish heart craved. When the father refused to furnish means for the farther education of his son, Magister Muller interceded for the boy, and, as an inducement, refused to accept any farther fees, and thus Samuel continued his attendance upon the furstenschule—an institution similar to our high schools in this country—until twenty years of age. Hahnemann's last essay on leaving this school was on a subject of his own choosing, "The Wonderful Construction of the Human Hand."

On Easter, 1775, Hahnemann left home for Leipzig to enter upon the study of medicine, with about $15 in money, the last he ever received from his father. Through the kindness of Bergrat Poerner, who understood the circumstances of his poverty, the lecture fees were all remitted, and for two years Hahnemann studied medicine in Leipzig, choosing such lectures as seemed most useful to him. During this period he was much of the time at work in various ways to earn the means necessary for his support while pursuing his studies. He was fortunate in finding an opportunity to instruct a young and rich Prussian in the French and English languages, and he also made many translations from the English for publication. Hahnemann worked so industriously that his labors enabled him to support himself, pay all his incidental expenses, and to save quite a sum besides. In order to both earn his living and attend all his classes, he slept only every other night.

His thirst for knowledge of practical medicine induced him to leave Leipzig for Vienna, where there were better advantages, as there was no hospital or infirmary in Leipzig.

About the time of his going to Vienna, he was swindled out of his hard-earned savings by the treachery of a supposed friend. In mentioning this fact in his short autobiography, Hahnemann says: "Repentance calls for reconciliation, and I therefore refrain from giving name and circumstances." This left him with only some $29, which was all the money he had, and he was forced to leave Vienna after a stay of only nine months. He was fortunate again in here making the acquaintance of Liebartz von Quarin, physician-in-ordinary to the emperor, to whom Hahnemann says he was "indebted for that which made him a physician. I had his affection and I might say his friendship. I was the only one of my time who was given the privilege of accompanying him in his calls on private patients. He loved and taught me as if I had been the only one of his pupils in Vienna, and even more, yet he never could expect any recompense from me." When Hahnemann's poverty compelled him to leave Vienna, Von Quarin was influential in procuring for him a position with Baron Bruckenthal, of Hermanstadt, as family physician and librarian. Here he remained one and three-fourths years, mastering several languages and doing much additional scientific studying. He arranged the baron's immense library and his incomparable collection of antique coins. With the means he had earned at Hermanstadt, he departed for Erlangen, in order to complete his medical studies, and here, on the 10th of August, 1799, he defended his thesis and received the degree of doctor of medicine.

After graduating Hahnemann says: "A Swiss could not be drawn more irresistibly toward his lofty Alps than a Chursachsen to the land of his birth." He therefore chose the mining village of Hettstadt, in Mansfeld territory, and there located in order to begin the practice of medicine, in the year 1780. The town, however, proved too small to satisfy him, and at the end of nine months he left for Dessau, where we find him in the spring of 1781. Here he seemed to do well and improved his time by devoting especial attention to chemistry and to the working of the mines in that region; but at the end of the year he again moved and located in Gommern, near Magdeburg. Here he did not do well, as, he said, there had never been a physician there and the people did not seem to think they needed one. However, while in this place, December 1, 1783, he married Henrietta Leopoldine Kuchlerine, stepdaughter of the apothecary Haeseler, of Dessau. Among the wedding gifts presented to the bride was one from Hahnemann's father. It was an ivory fan painted by himself. "Upon this the master is depicted as treating his first (lady) patient, sitting at her bed and giving her a spoonful of medicine. The other side shows the same lady recovered and sitting in her family circle. It is a charming little genre picture with its fine painting and its faithful portrait likeness." Of the character of Hahnemann's wife there are two impressions. One that she led her husband a Socrates and Xantippe sort of a life. But among those who knew her best, Mrs. Hahnemann's memory is cherished for her noble qualities, and she was respected as a faithful wife, a fond mother, and a woman who was devoted to the interests of her husband and children. A careful review of all the circumstances of her wedded life is sufficient to convince any one that the good woman was greatly maligned. She willingly followed her husband in all his various wanderings and frequent removals. When poverty threatened she was steadfast, and when the world turned against her husband she remained at his side the devoted wife, faithful to the last. In times of great need she parted with her jewels, bedding, and personal wardrobe for the maintenance of her loved ones, and was the cloud by day and the pillar of fire by night that guided and encouraged the great man on his difficult and disheartening way. She died March 31, 1830, in Cothen, where Hahnemann was living practically in exile.

From Gommern Hahnemann removed to Dresden in the year 1785. In this city he found still better facilities for study and here made the intimate acquaintance of the city physician Wagner, whom he refers to as "a model of incorruptible integrity." They became great friends, and, on the failing health of Wagner, Hahnemann, with the approval of the magistrate, succeeded to all his hospitals, and speaks of it as "a wide field for one charitably inclined." He seemed to enjoy his life here very much, for he says: "Four years in Dresden and vicinity thus passed for me more rapidly than they would to the unexpected heir of great wealth. In the midst of my growing family and to be nearer the source of the sciences I came to Leipzig about the time of Michaelmas, 1789, where I calmly awaited the act of Providence to decide what fortune would be apportioned to each day of my life, the length of which lies in His hands."

It seems, however, that the real motive which led Hahnemann to Leipzig had a deeper significance than "to be nearer the centers of knowledge." Already he had sounded the depths of allopathic lore, and found it a shallow pool compared to the unfathomable gulf of erudition and mystery it was supposed to be. While in Gommern he had written a work containing an account of his experience as a practitioner in Transylvania. It gives a somber view of the medical practice in general, and in reference to his own success in particular Hahnemann said that most of his patients would have done better had he left them. He became more and more discouraged over the results of his medical practice, for he observed that the treatment in the majority of cases was worse than useless. So that when he removed to Leipzig, it was virtually the abandonment of his work as a practitioner of medicine. He says: "It was painful for me to grope in the dark, guided only by our books, in the treatment of the sick—to prescribe according to this or that fanciful view of the nature of diseases, substances that owe to mere opinion their place in the materia medica. I had conscientious scruples about treating unknown morbid states in my suffering fellow creatures with these unknown medicines, which, being powerful substances, may, if they were not exactly suitable [and how could any physician know whether they were suitable or not, seeing that their peculiar special actions were not yet elucidated ?] easily change life into death, or produce new affections or chronic ailments which are often much more difficult to remove than the original diseases. To become in this way a murderer or aggravator of the sufferings of my brethren of mankind was to me a fearful thought. So fearful and distressing was it that shortly after my marriage I abandoned practice, and scarcely treated any one for fear of doing him harm, and, as you know, occupied myself chiefly with chemistry and literary labors."

Shortly after settling in Leipzig, he published his work on syphilis, and in it introduced to the profession the preparation still known by the name of "Mercurious Solubilis Hahnemanni." He gave a careful and accurate description of its mode of manufacture, administration, etc.

We come now to the year 1790—the year more fraught with interest to humanity than any yet recorded in the archives of scientific progress. It was the year of freedom coming to the benighted condition of medical knowledge. The year of emancipation in which the medical light, so long hidden in mystery and charlatanism, should shine forth to the world, and the shackles of blind custom and traditional medicine should be struck from its practitioner, and he should be left free to use the mind God had given him, and to pursue a better way in the treatment of his suffering fellow men.

Great consequences sometimes grow out of trivial circumstances. The falling of an apple led to the discovery of the law of gravitation; the singing of a tea kettle was the first hint of the power hidden in steam; taxation without representation led to the freedom of America; the shadow on the moon led Galileo to believe the earth was round; on the refusal of a request that his wages be raised a half dollar a month, Fernando Magellan changed employers and so became the first to circumnavigate the earth; on the shake of a peasant's head rested the fate of Bonaparte and the French at Waterloo; and the obscurity in the description of a single remedy (cinchona) led Hahnemann to found the grandest law in therapeutical medicine: Similia Similibus Curantur.

In the year 1790 Hahnemann was working at his translations for the purpose of earning his daily bread. Cullen's "Materia Medica" had been placed in his hands to be rendered from English into German. Happy day for medical science! Happy day for the millions of sick and suffering humanity in the ages to come! We homeopaths should erect a monument to the memory of Cullen, for he it was who was the unconscious author of our origin. As one after another of the remedies in this work came under Hahnemann's critical observation, he was more and more struck with the uncertainty and obscurity of the knowledge of medicine and medicinal action. He longed to raise the profession from the bogs and mists of uncertainty and to place it upon a sure and rational foundation. When he came to cinchona he felt more than ever impressed with the empty phantoms and mania for worthless hypotheses in the art of healing of that day. He determined to test the action of the drug in the only sure and reliable manner, viz., upon himself. He took a large dose of the famous remedy and observed the symptoms. Strange to relate, on that same day he suffered a veritable attack of ague or intermittent fever. He experimented upon others with the same result. Then came the question: Should not the power of cinchona which produced intermittent fever in a healthy person be the same as that which cured the disease? He experimented again and again with different remedies and with similar results. The query settled into a conviction, and the conviction into a law which he thus formulated: "Diseases are healed in the safest, easiest (least painful and most convenient) manner, as well as permanently, through such medicines as produce in the healthy body effects as near as possible resembling those of the disease. Or one must endeavor to heal diseased conditions with such remedies as produce in the perfectly healthy body diseased conditions most similar in character." This theory forms the center and basis of a school which has convulsed the whole science of medicine, the essence of which is the law Similia Similibus Curantur.

Hahnemann was now anxious to thoroughly test his new theory, but his poverty compelled him to labor with his pen for the support of his family. Fortune soon favored him in an offer from the reigning Duke of Saxe-Gotha to take charge of the insane asylum at Georgenthal in the Thuringian forest. As this gave him a competent income and ample leisure for study, he thankfully accepted the position. While at the head of this institution he succeeded in curing the Hanoverian minister Klockenbring, who had been rendered insane by a lampoon written by Kotzebue. The description of Klockenbring's insanity is a masterpiece in its way. Hahnemann is supposed to have been the first to advocate the treatment of the insane with kindness, and never allowed his patients to be punished by blows The same year, however, Pinel unchained the maniacs in the Bicetre, and it is a disputed question as to whom should belong the honor. We know, nevertheless, that Hahnemann did it working independently, and to-day the custom is universal in all well governed insane asylums.

He did not remain long in Georgenthal, and made several removals between 1792 and 1795; to Walschleben, Pyrmont, Brunswick and to Wolfenbuttel; from there to Konigslutter, where he lived for four years. All this time he was busily engaged in writing and translating, proving remedies and evolving the science of the new system. He freely published his researches and their results, deeming that his first duty always lay in giving his knowledge to his profession. Like all great reformers, however, he was greeted with a storm of abuse and opposition, instead of receiving the thanks of his medical brethren. At Konigslutter he had been phenomenally successful in the treatment of scarlet fever with belladonna, and this, with his growing popularity, aroused such a jealousy among his confreres that they induced the apothecaries to prefer charges against Hahnemann for dispensing his own remedies. The authorities issued an order enforcing the law against the self-dispensing of remedies, and Hahnemann, in the morning of his fame, was forced to quit the town in the year 1799. Think of this, ye practitioners of medicine who are beginning life's struggle in your profession. Samuel Hahnemann, forty years of age, a scholar and student, a man of giant intellect, a man who was master of more languages than the average physician had medical books in his library, whose Apothekerlexicon was the handbook on the German druggist's table, who taught the pharmacists the profession they followed; think of this man being driven from town to town because it was claimed he was not competent to dispense his own medicines!

On leaving Konigslutter, a crowd of people composed of friends and patients followed the wagon which contained Hahnemann's wife, family, and earthly possessions a long way on the road to Hamburg. Then a sad farewell was taken, the people thanking God for the benefit Hahnemann had been permitted to confer upon them. On this journey the wagon, in descending a precipitous portion of the road, was overturned. A daughter had an arm broken, and their infant son, Ernst, was so seriously injured that he died shortly afterward. Can you, my hearers, doubt of the bitterness that must have come to the heart of this great man over this loss of his darling child? Near where this accident occurred the family were detained six weeks on account of the injury of the daughter. At length they reached Hamburg, where Hahnemann could do but little. Then on to Altona; next to Moilen; then back to Saxony, where he tried to practice in Eilenberg. Persecution compelled him to move. He tried Machern, and next Dessau. During all this time he worked nightly, for the support of his family, in the translation of medical and scientific works. Poverty crowded upon him, and history says he was reduced to such straits that he was obliged to weigh out to each member of his family their portion of bread, that each one might fare justly. A little girl was taken ill, and asked that a portion of brown bread be put away for her, so that she might have it when she was better.

Hahnemann prosecuted his investigations in the science of medicine in spite of poverty and persecution. He ceased working at translations, and from 1806 devoted his time to original articles. "Æsculapius in the Balance," "A Pure Materia Medica," and the "Medicine of Experience," came forth rapidly. These productions raised such a storm of opposition, and the author was so reviled, that he gave up trying to educate the medical profession, and for a time wrote only for the benefit of the people. He published his subsequent articles in a literary and scientific journal.

We come now to the eventful year of 1810. Hahnemann was living in Torgau. He was fifty-five years of age, had been a doctor of medicine since 1779, and had been developing the law of Similia Similibus Curantur for twenty years. Truly, enough experience for a scientist to know what he was doing. He published his greatest work, The Organon, which was soon read in more languages than any book save that of Holy Writ. It ran through five editions, and was translated into English, French, Italian, Spanish, Hungarian, Polish, Russian, Danish, and Swedish. In this work for the first time was used the word homeopathy.

The name of Samuel Hahnemann was now a celebrated one throughout all Europe. In 1811 he removed once more to Leipzig, and adherents flocked to

him from every direction. Anxious to teach his new theory to the academic students, he sought permission and was informed he could do so by writing and defending a dissertation and by paying the sum of fifty thalers. On June 28, 1812, Hahnemann gave his famous dissertation in Latin on the "Helleborism of the Ancients." It was a masterpiece of scholarship and scientific knowledge, and produced a great sensation in Leipzig. One of his hearers, a Dr. Huck, says: "To hear Hahnemann, the boldest investigator of nature, defend the masterpiece of his genius and diligence, was an enjoyment truly heavenly. As I rode home in a dream I felt the solitude about me when I had to admit that I was unworthy to loosen his shoes He covered himself with glory. He remained victor"

At the delivery of this dissertation, Frederick Hahnemann acted as respondent. We will pause in our history to recite what is known of the life and fate of this the only son of the founder of homeopathy.

Frederick Hahnemann, born in Dresden the 30th day of November, 1786, was the pride of the family, and whose fate was so peculiar and so appealing to our sympathy as to make his life one of unusual interest to us. He was a stout, healthy little fellow as a child, and was familiarly called Fritz by his father. He had a brilliant education, spoke Latin, Greek, French, English, and Italian, and was conversant with Arabian, was a fine musician and a general favorite with all who knew him. He graduated in medicine at Leipzig, in 1812, although the year before he had entered the field as an author in defending his father against Hecker's attack upon The Organon. He purchased a drug store at Wolkenstein, in order to be freed from the law against the self dispensing of drugs, and there began the practice of his profession. His fame quickly spread, and his house was thronged with patients. He lived in pompous style and went from place to place with a coach and four. He contracted a matrimonial alliance with a widow, which gave great offense to his father, and this estrangement was never quite removed. Frederick Hahnemann's professional success soon aroused a jealously among his allopathic confreres, and a charge was brought against him of dispensing his own remedies. Though his cause was a good one and he could have undoubtedly won his case if he had remained for trial, he would not give his enemies the satisfaction of appearing before them, and so determined for once and all to avoid their persecutions and left home, wife, children, country, and practice to take up his life in a foreign land. He went to England and sent letters home at irregular intervals. These letters were so odd, the arrangement of the written matter on the page was so eccentric, and the mode of expression was so peculiar that his family were firmly convinced of his insanity. A letter written from London, in the spring of 1819, was so filled with this recklessness, so unusual to the careful student, that his father exclaimed in the most vehement grief: "My poor son is becoming insane!" The last line was written by Frederick from London, June 25, 1820, and he was forever afterward lost to the knowledge of his family. The father bent under the heavy grief and several times expressed his fear that his son had died in an insane asylum. Report has it that in 1830 a traveler calling himself Frederick Hahnemann had visited the interior of Pennsylvania, and had cured many persons by means of small powders. Nothing more definite was ever known of him.

For about nine years Hahnemann remained in Leipzig, winning many laurels, practicing continually, and constantly working to perfect homeopathy. He had many distinguished friends and illustrious patients. But envy and malice were at work against him. The apothecaries made a government complaint against him for dispensing his own medicines. In a rescript in December, 1820, the authorities admitted the justness of the apothecaries' complaint, and deprived Hahnemann of the right to dispense his own remedies. This, of course, destroyed the effectiveness of his labors, although it did not absolutely prohibit his practicing his profession. But crippled in his professional privileges, he was forced to say farewell to his native country.

Hahnemann's words regarding his new system were a veritable prophecy. He said: "Our art needs no political lever, no ribbons of worldly orders to develop it into something. Gradually it grows through the many weeds, sprouting high around it, from the unostentatious acorn into the vigorous sapling." The reigning Duke, Ferdinand, of Anhalt-Cothen, offered him a home in his city and appointed him hofrath, or court physician. Hahnemann removed to Cothen early in the summer of 1821. He felt the restraint of his smaller field, and was so embittered against the world as, for a long time, to seldom pass the threshold of his own door. He devoted himself with even greater assiduity to perfecting his system and recording his researches. His fame followed him and his practice was very large. People from all over Europe, from the United States, and even South America came to him for treatment, and many physicians made Cothen their Mecca to study the new school of medicine. Hahnemann was soon so crowded with business that he had to take an assistant in order to accomplish the work that was daily thrust upon him

While in Cothen a reunion was held which had a great significance for Hahnemann and homeopathy. It was on the 10th of August, 1829, the fiftieth anniversary of Hahnemann's graduating in medicine. It was his Doctor's Jubilee. Friends from far and near gathered to do honor to the great man. In a beautifully decorated room he was presented with a finely written programme of the occasion, a beautiful medal engraved by Kruger, of Dresden, with the portrait of Hahnemann, the date of his birth and graduation on one side, and his homeopathic axiom, Similia Similibus, on the other; a large oil portrait of Hahnemann well executed by Schoppe, of Berlin; the congratulatory diploma from the faculty at Erlangen, and many other tokens and expressions of regard. The venerable jubilant, with heartfelt emotion, gave thanks to his Almighty Father that he had been permitted to make so important a discovery. Congratulatory letters were received from the Duke and Duchess of Anhalt-Cothen, accompanied by the present of an antique cup and a golden casket ornamented with the initials of the Duke in brilliants. At this meeting was organized the first homeopathic medical society, the "Central Society of German Homeopathists," which was henceforth to meet annually on the 10th of August.

In 1831, when the cholera broke out in Europe, Hahnemann carefully studied the symptoms of the disease through the reports sent him, and decided upon camphor as the indicated remedy. Reports poured in from physicians, priests, and laymen in regard to the wonderful efficacy of camphor, and the consensus of opinions showed that hardly a death occurred where the remedy was used according to instructions. Hahnemann did not see a case of cholera during the epidemic. A finer illustration of the workings of our law of cure cannot be found. To prescribe for a malady without seeing it, to cover the picture of the disease with a remedy whose pathogenetic symptoms show it to be the simillimum, and to effectually stamp out the epidemic was a victory such as the medical world had never witnessed.

Hahnemann remained in Cothen fourteen years, one of the busiest and most honored scientific men in all Europe. We find him at the close of 1834 an old man of seventy-nine years, active, strong, and full of the faith in his new school. His wife had been in her grave for five years. A lady patient had come from Paris to consult the great Hahnemann in regard to a serious affection of the heart and lungs. Her name was Melanie d'Hervilly Gohier, an adopted daughter of Louis Gerome Gohier, who was Minister of Justice and President of the Executive Directory of the French Republic in 1799. This lady was an enthusiast in all that interested her. She was a daring rider and swimmer, possessed all kinds of rifles, had obtained permission to hunt, had been in the academy of painting, in some way had clandestinely been admitted to the dissecting room, and had taken a course of lectures on anatomy. A mutual admiration sprang up between this young Frenchwoman and the learned doctor, and it is facetiously stated that Hahnemann cured her of her lung trouble, but changed the heart affection into another one of a more chronic nature. They were married on the 28th of January, 1835.

The young wife, with her usual enthusiasm, was anxious to have her husband locate in Paris, and so fascinated the old man with her alluring representations of the fame and honor he would reap in France that he resolved to leave his fatherland and follow his wife to Paris. A farewell trip was taken to Leipzig, where Hahnemann gave a dinner to his pupils, and a reception to the great man was held. Early on the morning of the first Whitsunday, 1835, they left Cothen for Paris, and Germany never again saw the beloved founder of homeopathy.

In Paris, homeopthy was struggling for a foothold. There were a few representatives, but little was known of the new system. "Elle est morte!" or "On n'en parle plus!" were the common expressions regarding it. The coming of Hahnemann was to raise the banner on high and establish the cause on a sure foundation. By a royal decree, obtained through the kindness of M. Guizot, Hahnemann received permission to practice. One newspaper after another took up the cause and rallied to the support of Hahnemann and homeopathy. The following year a medal in likeness of Hahnemann was cast, and a deputation waited upon him to present him with it as a token of their honor for him and to thank him for locating in their country.

Patients flocked to see the great man and to secure his services. It is said that Hahnemann valued his advice very highly, as it required ten Louis d'or, or about $48, to consult him. Be this as it may, he also devoted a great deal of time to treating charity cases. He occupied a large hotel, and patients came to see him in veritable processions. Helen Berkeley, an American lady who visited Hahnemann professionally, gives her experience as follows: "In 1839, Dr. Hahnemann was residing in Paris, near the garden of the Luxembourg. During the winter of that year, desiring to consult him in behalf of an invalid friend, I made him my first visit. That I might obtain an audience as early as possible, I entered the carriage which was to transport me to his residence at a quarter past nine o'clock in the morning. After about half an hour's ride, finding that the coachman stopped his horses without dismounting, I inquired if we had reached our destination. 'No, madam, it is not our turn yet. We must wait a little while. See! there is Dr. Hahnemann's house,' he replied, pointing to a palace-like mansion at some distance. This mansion was surrounded by a mossy stone wall, with an iron gate in the center. Impatient at the delay, I leaned out of the window and beheld a long line of carriages in front of us, driving through the gate, and out again, as fast as their occupants alighted. This was vexatious; I had taken such especial pains to be early—and all to no purpose. But if there was any consolation to be found in the knowledge that others were even worse off than ourselves, I might have comforted myself by looking in the opposite direction. Behind us stretched a file of coaches, lengthening every minute, and already quite as formidable as the one in front. I had unconsciously taken my station in the midst of a procession slowly advancing to pay homage to the modern Æsculapius. I already knew something of Hahnemann's celebrity, but my opinion of his skill was marvelously fortified as I stared behind me and before me, and then at the empty carriages driving away around me.

"In about twenty minutes the carriage in which I was wondering and waiting, during that time having moved forward a few paces every minute, at last drove briskly through the iron gate, around the spacious court, and deposited us, to my great satisfaction, at the front entrance of Hahnemann's magnificent dwelling. Three or four livered domestics, assembled in a large hall, received the visitors as they alighted, and conducted them to the foot of the side staircase. At the head of the first flight they were received by a couple more of these bedizened gentlemen, who ushered them into an elegant saloon sumptuously furnished, and opening into a number of less spacious apartments."

Farther on, Mrs. Berkeley states that she waited three hours in the parlors before her turn came to visit Dr. Hahnemann.

Such was the ability of our great leader in his new home. His private life was filled with those events which go to make pleasant the life of one who has won fame through his own endeavors. Birthday celebrations, visits from admiring followers and indefatigable attention to perfecting his great work, filled his time to the fullest. His earnings were said to be 200,000 francs or about $40,000 annually, and that for a man well past four-score years of age.

Hahnemann's life was now nearing its end, and he was awaiting the Master's call, content to give up the struggle and be at rest with Him in whom he had so long trusted. July 28, 1839, he had written of himself: "Non inutilis vixi"—I have not lived in vain. Later on he wrote to a friend: "It is perhaps time that I quit this life, but I leave all and always in the hands of my God." On another occasion he wrote: "My conscience is clear; it bears me witness that I have ever sought the welfare of suffering humanity; that I have always done and taught what seemed to me best, and that I have never had recourse to any allopathic procedures to comply with the wishes of my patients, and to prevent them leaving me. I love my fellow-creatures and the repose of my conscience too much to act in that manner. Those who follow my example will be able, as I am, on the verge of the grave, to wait with tranquillity and confidence till the time comes when they must lay down their heads in the bosom of the earth and render up their soul to a God whose omnipotence must strike terror into the heart of the wicked."

The sun of his life set in glowing colors. Each spring time for some years past Hahnemann had been subject to an attack of bronchial catarrh. The 15th of April, 1843, he was taken so seriously ill with his old trouble that his wife admitted no one. Several times he was reported as dead, and the statements as many times disproved. This condition ran on through the rest of the months of April, May and June, with variations from better to worse. Hahnemann's mental faculties were retained to the last, and he gave advice regarding the choice of remedies for his affection that showed the wonderful memory, knowledge and judgment of the man. He was treated by his wife and Dr. Chatran. He suffered more from attacks of dyspnœa toward the end. It was during one of these attacks that his wife said to him: "Providence should really owe to you an exemption from your sufferings, because you have alleviated those of so many others and have borne so many hardships in your laborious life." He replied: "To me? Why to me? Every one in this world works according to the talents and powers which he has received from Providence, and more or less are words used only before the judgment-seat of man, not before the throne of Providence. Providence owes me nothing, but I owe it much. Yes, everything!"

"He retained his mental faculties to the last moment, and though his voice grew more and more indistinct, his broken words showed the continued clearness of his mind and the calmness with which he saw his end approaching. At the very beginning of his illness he had told his people that this would be his last, as his frame was worn out."

Samuel Hahnemann died at five o'clock on the morning of July 2, 1843, aged eighty-eight years two months and twenty-two days. A mistake as to this date was probably caused by a typographical error. The only two works published in the German language relative to the date of his death, Hahnemann's Life and Works, by Albrecht, and History of Homeopathy, by Ameke, give the day as June 4. But the cuts of the monument erected to his memory in Leipzig, as well as other authorities, give it as July 2. To settle the question, I wrote to Dr. R. E. Dudgeon, of London, who should know more of Hahnemann than any English-speaking homeopath. He replied: "I thought the best way to answer your question was to ask his grandson, Dr. L. S. Hahnemann. He tells me that the true date of his grandfather's death is July 2, 1843, and he should know, as he was at the old man's funeral, if not exactly 'in at the death.'"

At this time, Jahr writes: "I had repeatedly resolved to call there when I received a note from Mrs Hahnemann asking me to call on her that day. I went immediately, and was admitted at once to Hahnemann's bedroom. But imagine my horror, instead of there finding Hahnemann, the dear, friendly old man, greeting me with his smile, I found his wife stretched out on his bed in tears, and next to her him lying cold and stiff, having passed five hours before into that life where there is no strife, no sickness, no death. Yes, dear friends, our venerable father has finished his course. Paralysis of the lungs has freed his spirit from its tired frame after an illness of six weeks."

Hahnemann had no public funeral. His remains were embalmed by Ganal, taken to the cemetery of Montmartre on the rainy morning of July 11, 1843, and buried near the left of the entrance. Only his wife, one daughter and her son, and the servants followed the body to the grave.

One month after Hahnemann's death, the Central Society of German Homeopathists met in Dresden and resolved to erect a monument to the beloved leader. The statue of Hahnemann was executed by the sculptor Steinhauser and then cast in bronze in Rome. With appropriate ceremonies the corner stone was laid in Leipzig and the completed monument unveiled and dedicated on August 10, 1851. Hahnemann, living in Leipzig, was persecuted and driven from the city. Dead, his memory was cherished in the hearts of his followers and his fame emphasized in marble and bronze. His was a life well spent, a benefactor to suffering mankind, a physician, and a true minister of God. He lives with us to-night, and thousands of orisons ascend heavenward to bless the memory of the greatest physician of past or modern times—Samuel Hahnemann, the sage of Cothen, the founder of homeopathy.

PUTTING IN PLACE AND ADJUSTING THE OBJECT GLASSES OF REFRACTING TELESCOPES.*

By J. A. BRASHEAR.

AFTER the lenses of an objective are thoroughly cleaned by the method given in Popular Astronomy for last month, the next thing to do is to put on the three pieces of tinfoil usually placed on the inner concave curve for the purpose of separating the lenses

* From Popular Astronomy.

slightly so as to prevent them from touching one another.

Mark three places equidistant on the edge of the lens on which the tinfoil is to be placed. For a 4 in. lens cut a strip of tinfoil ⅝ in. wide and long enough to handle well. Place a drop of mucilage—good quality—on a piece of letter paper and with the finger take up a very small quantity and spread it on the end of the strip of tinfoil, taking care not to cover much more than is to be pasted on the edge of the glass; quickly lay the foil in place, letting it lap over about ⅛ in. for a 4 in., proportionately more for larger glasses. Lay a piece of clean letter paper over the foil and press down by rubbing with the thumb nail. Let it remain a little while to dry, then slice it off with a sharp knife as our mothers used to slice off the extra dough from the edge of a pie pan. Be sure to trim off the part of the tinfoil that you have pasted over, as that paste or extra mucilage will form an extra thickness which may do an injury. Then put on the second and third pieces in the same way. If neatly done, no cleaning is necessary around the foil.

Some of our German friends use strips of a postage stamp, and I believe they would come in first rate if we are willing to break through the conventional tinfoil. I have measured quite a good number of stamps with the gum on them and find the thickness does not vary greatly from twenty-five ten-thousandths of an inch, about one-fortieth of a millimeter. This is rather thicker than the tinfoil the writer is in the habit of using for objectives whose inner curves are equal, but with such a slight difference as there would be between the stamps and the tinfoil with its adhesive gum I think it perfectly safe to use the strips of a postage stamp in place of the foil. With all the writer's experience he is never sure that the amount of gum is always the same on the three strips of tinfoil, whereas a careful measurement of a number of stamps did not show a variation of three ten-thousandths of an inch. Columbian or other forms of the longer stamps could be used for larger glasses.

Some objectives I have met with, particularly those of the Fraunhofer Herschel curves, have enough difference in the inner curves to touch in the center. In the absence of a spherometer to measure the curves, this may always be known by looking through one of the lenses at a rather low angle, when Newton's rings will at once be seen at the point of contact of the two lenses. In this case the lenses must be separated by a greater thickness of tinfoil or doubling up of the stamp strips.

The lenses should be placed together carefully. Small lenses may be readily placed together while lying horizontally. Large lenses should always be set on edge and placed together in a vertical position, then firmly grasped with the hands and laid on a cushion, the same as used in taking objective out of its cell. The block or book on which the cushion of cheese cloth is laid should be somewhat smaller than the glass, then the cell will readily slip over it. In some forms of cell, each of the lenses is mounted separately, indeed all our later forms of cells for larger objectives are made this way, so that it is much easier to place the lenses together, but what is written here holds good for any form of mounting.

If the objective is marked to go together in a certain way, which is usually the case if it has been corrected locally for irregular density, etc., the lenses should always be replaced in the same manner. At any rate, it is safe to place the lenses together as the maker placed them.

In nearly all objectives made up to ten years ago the crown lens was placed in front. In objectives made by Steinheil and the writer the flint lens is placed in front, and it is of course essential that the proper lens should always be placed in the position designed by the maker. If there is a suspicion that the objective is not doing good work because of being wrongly placed (and this has happened more than once), it is an easy matter to reverse it and test it. The story it tells will be quickly understood by the observer if he have only "half an eye."

And now a word about adjusting an objective. Wallaston's method of holding a candle at the center of the eye tube near the focus has been given in a number of excellent works, but I consider it not at all suited to the purpose, and the method of using a sort of spherometer with a telescope attached to set on the objective at the equidistant points and observe the image at center of eyepiece is well enough perhaps for experimental purposes.

The simplest and best way is to put the cell in place on the tube, and observe the image of a bright star, either an artificial one, say that produced by the sun shining on the glass insulator of a telegraph line at a sufficient distance to enable it to be brought to a focus, or a first or second magnitude star in the sky. The image of the star should be circular, and with a sufficiently high power, say 40 to the inch of aperture, the diffraction rings around it should be true circles and these circles should be concentric with, i. e., equidistant from, the central image. If this is not the case, the treatment is simple where there are the ordinary three adjusting screws. If the objective has the flint glass front, as in the Steinheil and our own form of objective, the correcting screws should be so operated that that part of the objective toward which the image seems to flare should be pushed away from the eye end. If the objective has the crown lens front, the reverse treatment is necessary, i. e., that part of the objective toward which the flare extends should be drawn toward the eye end, and the observer should spare no pains until the image is clear and symmetrical. To give the reader an idea how a perfect star image should look, the following simple experiment will be useful. Lay a spectacle or any convex lens on a place where the sun will shine on it. Punch a hole through a visiting or similar card, look through the hole in the card at the image produced by the sun shining on the convex surface—standing two or three feet away from it. If the hole is punctured with the point of the pin, the image of both star and its diffraction rings will be quite similar to their ideal appearance in a 2½ in. or 3 in. telescope. A large hole reduces the diffraction rings as in larger glasses and gives one a most excellent idea of how a star ought to appear in a well corrected telescope. I think it is not necessary to consider the colors shown on opposite sides of the stellar image when the adjustments are not perfect, as the diffraction rings are an all-sufficient guide, nor is it necessary now to speak of irregular images which are not a function of bad adjustment, though they may be of compression of the objective in its cell.

In many of the smaller telescopes the cells are screwed into place. These the maker should always adjust before sending them from the workshop. I have seen it advised to "gently tap the ring holding the cell on the proper side, to adjust the objective," but this is bad advice. If you cannot send it to the maker, send it to a first class mechanic, get the tube mounted on a carefully centered mandrel in the lathe, and have the objective end refaced until your image is perfect, for without it you cannot expect to do the best work with your glass.

AMUSING TOYS.

THE SURPRISE COFFEE MILL.

THE coffee mill that we illustrate herewith would assuredly not be looked upon favorably by prudent housewives who are desirous of never losing a minute of their time. As an offset, however, it will delight children and those who fancy ingenious knickknacks.

In its external form this mill resembles the ordinary

THE SURPRISE COFFEE MILL.

apparatus daily used for grinding coffee, but in its interior, instead of a grinding arrangement, it contains a small clockwork movement that actuates a music box and, simultaneously, a system of jointed levers that set in motion a small automaton. After the clockwork movement has been wound up and the catch that stops it has been freed, the cover of the mill is seen suddenly to rise, while at the same time there appears a figure of a handsomely dressed darky, who holds in his hand a cup of coffee that he carries to his lips in turning his head with the marks of the liveliest satisfaction. Then, having tasted the beverage, always to the sound of music, the darky re-enters the interior of the mill, whose cover shuts down and then rises again an instant afterward and permits the tireless coffee drinker to devote himself to his passion.

THE BICYCLE PUT TO PRACTICAL USE.

An ancient proverb very wisely recommends us to combine the useful with the agreeable. The invention of indoor training machines for cyclists permits of putting this proposition in practice in the happiest manner. As well known, for some time now, cyclists who have made a record and who are condemned to remain at home have found a means of replacing their visits to the velodrome by a course of indoor training, by means of which they keep their muscles in good condition.

Nothing is more simple than the arrangement devised. The bicycle is firmly mounted upon a special support that leaves its wheels free to revolve.

The cyclist seats himself upon the saddle, and pedals with the whole force of his legs. Meanwhile, in thus causing the wheels of his machine to revolve to no effect, the rider puts forth, as pure loss, an important sum of energy.

Why should a utilizable force be thus lost without benefit to anybody? This is evidently what was asked by the author of the device shown in our engraving, and who, with much intelligence, and very appositely, has discovered a practical process of preventing a very appreciable source of energy from remaining unemployed.

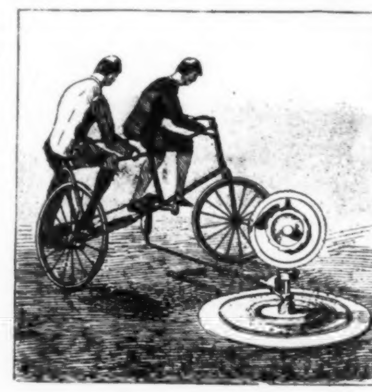
In his system, the driving wheel, instead of revolving idly, is connected by an endless cord with the flywheel of a sewing machine or any other small apparatus that requires a moderate force to set it in motion. Owing to this arrangement, each kick of the pedal is utilized, and the cyclist experiences the sweet satisfaction of knowing that, while training himself in view of a coming race, he is also doing something useful. As may be seen, nothing could be better. But who would ever have expected to see the bicycle thus converted into an apparatus of domestic and practical utility?

THE BICYCLE PUT TO PRACTICAL USE.

A TOY BICYCLE.

We have already described several small mechanical toys characterized by their real ingenuity and in which the motion was assured by means of a heavy flywheel to which a rapid revolution was given either through a cord or by means of a spring.

The little toy bicycle here figured is the latest application of this particularly simple system. When the spring that is designed, upon unwinding, to actuate the flywheel is wound up and then left to itself, we at once see the apparatus begin to run and the little riders move their legs just as if they were really racing



A TOY BICYCLE.

over the track of a velodrome in order to establish a record.

The motion of the legs, which is exceedingly true to nature, is obtained in the most simple manner imaginable. The feet of the racers are attached to the pedals, which carry them along in their rotary motion and thus cause them to ascend and descend alternately. —Revue Universelle.

THE CHEMISTRY OF CLEANING.*

By Prof. VIVIAN LEWES.

As a great city grows, and the agglomeration of struggling humanity increases, such questions as the disposal of sewage and other waste matter rise from comparative insignificance into problems of almost insurmountable difficulty; and while we are able to put the burden of cleansing our towns upon the urban authorities, the responsibility of keeping our homes and bodies in a condition of at least sanitary cleanliness devolves upon the individual, and a knowledge of the causes of dirt and the methods by which it can be removed cannot be regarded as devoid of interest, or at any rate of utility.

Observation shows that in our town houses only a very short interval of time is needed to cause a considerable deposit of dust upon any horizontal surface, while vertical surfaces and draperies, especially if their surface be rough, also accumulate a perceptible quantity, although of a lighter and more finely divided kind. We also find that this dust is borne to its resting place by the air which penetrates from the outer atmosphere, and that its deposition is caused by the comparative condition of rest insured to it by the absence of wind or violent currents.

The presence of these air-borne particles of solid matter can be made visible in any town by allowing a beam of sunlight or a ray from an electric lantern to pass through the air of a darkened room. If the room be filled with air previously filtered by passing it through cotton wool, the beam of light is invisible

* From a lecture delivered at the London Institution.

until it strikes the opposite wall; but if the air be unfiltered, the path of the beam is mapped out by the suspended matter reflecting and dispersing portions of it, and so becoming visible to the eye as "the motes in the sunbeam." The heavier the nature of the particles the more quickly will they settle, with the result that the dust on horizontal surfaces, such as the tops of sideboard, piano, and mantel board, may be expected to differ somewhat from the lighter form, which has continued to float until contact with vertical surfaces has brought it to rest.

These particles of dust are composed of matters of the most varied nature, and will be found, when collected, to consist partly of mineral and partly of organic substances.

The heavier portions of the dust are found to contain ground-up siliceous matter, pulverized by traffic in the road; small particles of salt carried inland by winds from the sea, together with sulphate of soda, with other impurities of a local character. If a sample of dust be collected and carefully ignited, the organic matter will be burned away and any ammonium salts volatilized, while the mineral portion will be unacted upon; and in this way it has been shown that more than one half of the suspended matters in the air are of organic origin, a large portion of this organic matter consisting of germs which are capable of setting up fermentation, disease and decay.

It is only within the last few years that the importance of the work done by the solid particles of dust floating in the air has been recognized, and it is to Pasteur that we owe the knowledge that these germs set up the various processes of organic decay, by which the waste matter derived from vegetable sources is once again resolved into the water vapor and carbon dioxide used by nature as the foundation of all organic creations. It is the almost imperceptible germs floating in the air which start this marvelous natural action—germs so minute that it requires the strongest microscope to detect them, yet so potent that the whole balance of life hangs on their existence. These facts show us that not only has dust a most marvelous history, but that in it Nature has disguised her most important factor for cleaning the face of the earth from waste matter of both mineral and vegetable origin.

The surface soil when mixed with water gives the mud which dirties our boots, and forms clots on the train of our skirts; but this, as well as the dust which has settled in our living rooms, and merely clings mechanically to the surfaces upon which it has deposited, may be removed by such simple physical means as the duster and brush. When dust has found its way into a fabric such as a carpet, it requires considerable force to again dislodge it, and this is applied by means of the broom; but in vigorous sweeping we find that the largest proportion of the dust is driven up into the air, only to resettle once again on other surfaces, so that although we can make the nuisance "move on," we do not in this way remove it, and experience has taught our servants that wet tea leaves scattered on the carpet before sweeping lessen this evil. In some cases, instead of using this method, it has been argued that it must be the moisture which acts in preventing the raising of the dust, and the carpet has been sprinkled with water. This converts the dust into mud, which remains fixed in the fabric while the sweeping is going on, but as soon as the water has evaporated from it, again reasserts its right of rising as dust.

When, however, wet tea leaves, damp sawdust, or even moistened sand is scattered over the surface to be swept, the dust when dislodged adheres to the moistened substance and is removed. In choosing moist bodies for this purpose, the only points to consider are that they must have no staining action on the carpet, must not be too wet, and must not be so finely grained as to sink into the fabric, nor so clinging as to resist easy removal by the broom.

It is manifest, however, that the mechanically held dirt which we have been considering differs very considerably from the dirt on our skins, and on linen in contact with our bodies, which, although derived from the same sources as the dust on the furniture, resists any ordinary mechanical process for its removal, and rinsing dirty hands or linen in cold water has but little cleaning effect, while if the hands are afterward dried in the usual way a transfer of a portion of dirt to the towel takes place. If we carefully notice the portions of our skin and shirt which become most soiled, we at once observe that it is where the skin is exposed to air, while the linen which is in contact with both air and skin becomes dirty more quickly than when exposed to either alone.

The part played by the atmosphere is made clear by the facts which we have already been considering, but the action of the skin introduces a new and most important factor. For the healthy carrying on of the functions of life, nothing exceeds in importance the skin with which our body is covered. We may live for days without giving our stomach any work to do, the liver may cease action for several days before death ensues, but it is impossible to survive for the same length of time if the functions of the skin are entirely stopped. The skin not only plays an important part in throwing off and getting rid of waste matter from the system, but it is also credited with being an important auxiliary to our lungs; and experiments have clearly shown that if the skin of animals be coated in such a way as to completely stop its action, a very few hours will bring about death.

If we examine the structure of the skin, we find that it is built up of two distinct layers, an outer skin called the cuticle or epidermis and an inner termed the cutis or dermis. A third layer intermediate between these two used to be looked upon as a third skin, but more recently has been recognized as being only a transition form of the outer skin.

The cuticle or outer skin consists of several fine layers of scales which gradually assume a more rounded and granular form the deeper one gets into the cuticle. These rounded granules form the middle skin of the old observers, and as the outer portion of the cuticle roughens and scales off as scurf, these granules gradually flatten and form the new surface to the outer skin; and we differ therefore from other scaly reptiles by being continually in a condition of renewing our skin, while most reptiles and fish cast their scaly covering in one operation.

No nerves or blood vessels find their way into this outer skin, as may be seen when it becomes detached from the inner skin in the formation of a blister, the outer portion of which is devoid of sensation. The lower or true skin varies in thickness, being thicker in the palm of the hand and sole of the foot, where most resistance is needed. When we look at the skin of the hand, we notice delicate grooves in it, which, examined through a magnifying glass, are seen to be pierced with small orifices; and if the hand be warm, minute shining drops of perspiration will be seen issuing from them.

The glands for the secretion of the perspiration are set in the lower side of the inner skin and are in connection with the capillary network of blood vessels which cover the surface of the body. The gland or duct which conducts the perspiration to the surface of the skin is about a quarter of an inch in length, and is straight in the true skin, but becomes spiral while traversing the outer skin. Over thirty-five hundred of these small ducts have been found to exist in a single square inch of the skin, and it has been computed that the aggregate length of the sudoriferous ducts in the body of an ordinary sized man is about twenty-eight miles. These little glands and ducts perform the important function of throwing off the moisture produced during the combustion of waste tissue by the blood-borne oxygen of the body, and secrete about twenty-three ounces of perspiration in the twenty-four hours, which under ordinary conditions evaporates, without our noticing it, into the air, but under conditions of considerable exertion or unusual heat accumulates as beads of perspiration.

The throwing off of the perspiration and its evaporation on the skin is a beautiful natural contrivance for regulating the temperature of the body, as the conversion of the perspiration into vapor renders latent an enormous amount of heat, which, being principally derived from the body, keeps it in a comparative state of coolness even when subjected to high temperatures.

In the twenty-three ounces of liquid so secreted in the course of the twenty-four hours there will be found rather more than an ounce of solid matter, which is left when the liquid portion of the perspiration evaporates, and tends to clog the pores of the skin, and it is the removal of this by the morning tub and rough towel which is responsible for a considerable portion of the refreshing influence of the bath.

Besides these sudoriferous glands, however, there is a second set, called the sebaceous glands, the ducts of which are spiral, and open generally into little pits, out of which the fine hairs which stud the skin grow, and these glands secrete an oily or waxy substance, which nourishes the hair, and also keeps the outer skin smooth and pliant. This waxy substance is developed in largest quantity inside the ear, where it serves to protect the more delicate portions of that organ; and, next to the ear, these glands are found most abundantly on the face and other portions of the body which are exposed to external influences and friction.

It is the presence of this oily secretion which holds the dirt glued to the skin and being also rubbed off on the inside of the wristbands and collars of our shirts, causes these portions of our linen to become the most soiled. We may look upon this form of dirt, therefore, as b ing glued on to the surface by oleaginous materials, which, being insoluble in water, resist any mere rinsing; and the most important function of our cleansing materials is to provide a solvent which shall be able to loosen the oil, and so allow of the removal of dirt from the skin. The skin, however, is not the only source of oily matter, and in all fibers of animal origin more or less fat is to be found, which, although not in sufficient quantity to play any very important part in the fixation of dirt, still adds its iota to the general result.

We notice, moreover, that the air of a big town has a far greater dirtying effect than country air, this being partly due to the fact that the number of solid particles per cubic foot of atmosphere are greatly increased, but chiefly because country air does not contain certain products of incomplete combustion, which are to be found in all large towns. In London we annually consume some six million tons of bituminous coals, and if we examine the smoke which escapes up our chimney during the imperfect combustion which the coals undergo in our fire grates, we find that not only will that smoke contain small particles of unconsumed carbon in the form of blacks or soot, but also a considerable quantity of the vapor of condensible hydrocarbon oils, which, depositing on the surface of the solid particles of floating dirt, gives them an enhanced power of clinging to any surface with which they come in contact.

Hydrocarbon oils of this character are not as a rule affected by the solvents which we utilize for loosening the dirt which is held to our skin by animal grease; but there is no doubt that the dirtying influence of town air is greatly increased by their presence.

If we take any grease of vegetable or animal origin, we find that it can be dissolved in liquids containing free alkalies, this term being applied to the compounds formed by water with the soluble metallic oxides, which, when dissolved in water, give solutions having a soaplike taste, affecting the color of vegetable extracts, such as that obtained by the red cabbage, and possessing the power of neutralizing the acidulous properties of the compounds we call acids.

If we take two metals discovered by Sir Humphry Davy in 1807—potassium and sodium—and expose them to dry, pure air, they rapidly become converted into a white powder by absorbing oxygen from the atmosphere, and form compounds which we term respectively oxide of sodium and oxide of potassium. These oxides, when dissolved in water, enter into combination with a portion of it, producing sodic hydrate and potassic hydrate, two substances which have pre-eminently the properties which we term alkaline, and which exert a strong solvent action upon all forms of animal and vegetable grease. These solutions exercise a wonderful power of cleansing upon the grease-bound particles of dirt which veil our skin, but so strong is their solvent power upon animal membrane that not only do they dissolve fatty matter, but also the cuticle itself, so that they are manifestly unfitted for removing dirt from a tender skin, and we are forced to look further afield for a grease solvent.

If instead of dissolving our sodic and potassic oxide in water we had left them exposed to ordinary air, we should have found that they gradually attracted from the atmosphere a gas called carbon dioxide, which exists in all air to the extent of four parts in ten thousand, and that by combining with this gas they became converted into sodic and potassic carbonates, bodies which we call salts, and which, although not so violent in their action upon the skin, will retain to a certain extent their solvent action on fatty matters.

The carbonates of sodium and potassium are found in the ashes of many vegetable and animal substances, and in the earliest records which have been discovered we find mention of the cleansing power of wood ashes, the ashes of certain marine plants, seaweed and "natron," which is an alkaline efflorescence from some kinds of soil; nor has the use of ashes for this purpose entirely died out at the present time.

As early as A. D. 69, however, we find that the elder Pliny mentions another form of cleansing material made from tallow and ashes, the components most recommended being goat's suet and the ash of beechwood; while the ruins of Pompeii were found to contain a fairly perfect soap factory.

Although soap and Christianity date from the same period, it was only at the commencement of this century that the classical researches of Chevreul on the constitution of fats gave the key to the reactions taking place during its formation, while even at the present time we probably only know a true explanation of part of the actions which lead to its cleansing effect upon the skin.

If we take sulphuric acid diluted with water, we find that it has certain well-marked characteristics which leave no room for doubting its acidulous nature; and if we pour a few drops of it into the violet-colored solution obtained by boiling sliced red cabbage in water, the violet solution at once becomes bright red. On repeating this experiment with the violet cabbage solution and a few drops of sodic hydrate solution, we obtain a vivid green color; and now on mixing the solution rendered red by the acid, and the second one turned green by the alkaline base, we once more obtain the original violet color and on examining the solution can find no trace of either acid or alkali, but can distinguish the presence of a compound called sodic sulphate, which can be obtained in the crystalline form by concentrating the solution, and such a compound formed by the union of an acid and a base we are in the habit of calling a salt. During the combination of the sulphuric acid and sodic hydrate to form sodic sulphate, we also had water being formed, which, like the neutral salt, had no action upon our colored solution. If we had carefully weighed our sulphuric acid and the sodic hydrate, we should have found that it is only in certain definite proportions that they unite to give a solution without effect on the vegetable coloring matter.

One of Chevreul's greatest discoveries was that in tallow—the fat of oxen or sheep—you had a salt of organic origin, from which, by decomposing the tallow with heated steam, you could obtain the sweet viscous liquid "glycerin," which played the part of base in the compound, and two acidulous compounds—one a lustrous white wax, called stearic acid, and the other an oil called oleic acid.

Now a salt can have its base replaced by another base. If I take two solutions, the one containing sulphate of copper and the other chloride of iron, and add to each sodic hydrate, decomposition takes place in each case, sodic sulphate is left in solution, and the hydrates of copper and iron being insoluble in water, separate out as precipitates. In the same way, if we add sodic hydrate to tallow, glycerin separates out, and two salts—sodic oleate and sodic stearate—are formed, a process which we call saponification, as the two sodium salts are "soaps."

It is not necessary to use tallow; any vegetable or animal fat or oil will give reactions of a similar character, and it may be broadly stated that soap is formed by the action of sodic or potassic hydrate upon fats or oils which contain fatty acids.

It is only potassic and sodic hydrates which can be used for ordinary soap-making, as the soaps formed by the combination of other metallic hydrates with the fatty acids are insoluble in water, and therefore useless for detergent purposes. The soap formed by using sodic hydrate has the property of setting hard, and all the ordinary forms of washing soap contain sodium as the base. The potash soaps are far softer and do not set; the soft soap used for scrubbing and cleansing in many manufacturing processes, and also a few toilet creams and shaving pastes, being of this character.

It would occupy far too much time and would, moreover, be outside the scope of this lecture, to go into the details of the manufacturing methods by which soap is made on the large scale, and if I give a rough idea of the general processes employed, it will be sufficient for the purpose.

Carbonate of soda is first converted into hydrate by dissolving it in water and then boiling with quicklime. Quicklime consists of calcic oxide, and this, when put into the vat containing the sodic carbonate in solution, combines with water, forming calcic hydrate, which then reacts with the sodic carbonate, forming calcic carbonate or chalk, which, being insoluble, sinks as a mud to the bottom of the vessel, while sodic hydrate remains in solution.

The solution of sodic hydrate, called caustic lye, is made in different strengths, and tallow is first boiled with a weak lye, and as the conversion into soap proceeds, so stronger lyes are used until the whole of the fatty matter has been saponified. If a strong lye had been used at first, the soap as it formed being insoluble in strong alkalies would have coated the surface of the fat and prevented its complete conversion.

If at the end of the saponification process the alkaline solution is sufficiently strong, the soap will, on standing, separate as a fluid layer on the surface of the spent lye, which contains the glycerin set free during the saponification; but in any case separation can be rapidly brought about by adding salt to the liquid, when the soap, being insoluble in salt water or brine, separates out and is removed and placed in moulds to harden. The block of soap so cast is then cut first into slabs and then again into bars. A soap made in this way with tallow or lard as the fatty matter would be "white curd," while if yellow bar is re-

quired, resin is added to the mixture of lye and soap after most of the fat has saponified.

When resin is boiled with alkaline solutions, a compound is formed by the direct union of the resinous acids with the alkali, which strongly resembles ordinary soap, so that the yellow soap is really a mixture of fatty and resin soap, and when the ingredients are of great purity the product goes by the name of "primrose" soap. Bar soaps so made on a large scale are, as a rule, the stock from which the various forms of toilet soap are made by processes intended to render them more attractive for personal use, but generally the consumer gets far better value for his money, and far less injury to his skin, by using a good "white curd" or "primrose" soap than by employing a high-priced toilet soap, while cheap toilet soaps, especially cheap transparent soaps, should be studiously avoided.

The demand made by consumers for cheap soaps, which in many cases are sold retail at prices considerably below the wholesale market price for a true soap, has given rise to the introduction of highly watered soaps, caused to set hard by the addition during manufacture of sodic sulphate, which enables the manufacturer to make a so-called soap often containing less than twenty per cent. of true soap.

Having got our soap, the next point is to try and gain an idea of the way in which it acts as a detergent. Supposing we are fortunate enough to have a sample of pure neutral soap, we find that, on dissolving some of it in water, it undergoes a partial decomposition into alkali and fatty acid, this action being called the hydrolysis of soap. The small quantity of alkali so set free attacks the fatty matter which glues the dirt to the skin, and by dissolving it loosens and enables the water to wash off the particles of dirt. If this were the only action, however, soap would have no advantage over soda, a solution of which would equally well perform this part of the operation. As the soap decomposes and the alkali removes the grease and dirt, the fatty acid liberated simultaneously from the soap comes in contact with the newly cleansed skin, and not only softens and smooths it, but also neutralizes any trace of free alkali, and so prevents irritation and reddening of the cuticle.

These are probably the main actions by which soap cleanses, but other causes also play a subsidiary part. We know that a solution of soap causes a lather when agitated, this being due to the cohesive power given to the particles of which the liquid is built up by the presence of the soap, a phenomenon which also enables us to blow bubbles with the soap solution on account of the strength of the fine film of liquid—a property which is not found in water alone.

The power of cohesion which the soap solution possesses is in all probability an important factor in removing the particles of dirt from the skin at the moment that they are loosened by the action of the alkali. Prof. W. Stanley Jevons suggested yet a fourth way in which the soap solution might act; when finely divided clay is suspended in water, the microscope reveals the fact that the minute particles are in rapid movement, and hence settle but slowly in the liquid. This movement he christened pedetic action, and he observed that the addition of soap or silicate of soda—often used in soap—to the liquid enormously increased this agitation of the particles, which would tend to aid the breaking away of the dirt particles the moment they were set free.

Many soaps, even among the varieties intended for the toilet, contain a considerable excess of free alkali, which, being greater than the liberated fatty acids can neutralize, causes most painful irritation of the skin, as is testified by the smarting which annoys the chin after the use of certain shaving soaps; and every lady knows that an alkaline soap, when used for washing the hair, renders it harsh and brittle, and destroys the gloss; but a rapid rinse with water containing a few drops of vinegar will neutralize the free alkali and prevent much of the mischief.

We have now dealt with our grease solvents and dirt looseners, but without the aid of water they would be useless; and experience teaches us that the source of the water used for cleansing has a great deal to do with its efficiency.

As the newborn raindrops fall from the breaking clouds, they are practically pure water, containing at most traces of gaseous impurities which the mist has dissolved from the upper strata of air while journeying in the form of cloud; and where the rain is collected in the open country, it gives us the purest form of natural water healthful to drink, because it is highly aerated, and free from all impurity, organic and inorganic, and delightful to wash in because of its softness and the ease with which the soap gives a lather.

In towns, however, a very different state of things exists, as the rain in falling washes the air from a large proportion of the suspended organic matters inseparable from a crowded city, and also from the unburned particles of carbon, which incomplete combustion allows to escape from our chimneys; and charged with these, it still collects more dirt of various kinds from the roofs of our houses, and finally finds its way into our water butts as the semiputrid sludge which often causes the true-bred cockney to wonder "if this so-called purest form of natural water is so foul, what on earth must the other forms of water be like?" If in the country the rain water is collected and stored in suitable reservoirs, then we have the most perfect water that can be obtained for washing and cleansing purposes.

In the passage of the rain through the air small quantities of carbon dioxide or carbonic acid gas are dissolved from the atmosphere, while in slowly percolating through the surface soil on which it has fallen the water is brought in contact in the pores of the soil with far larger volumes of this gas, which is being continually generated there by the decomposing vegetation and other organic matter in a state of decay. Under these circumstances the water becomes highly charged with the gas, and sinks on through the ground until it comes in contact with some impermeable strata through which it cannot penetrate, and here it collects until a sufficient head of water has been formed for it to force its way along the strata to the surface of the earth, where it now appears as a spring, and during this passage through the earth it has dissolved everything that will yield to its own solvent action or to the activity of the carbon dioxide, which dissolved in water forms the weak carbonic acid, a compound which will dissolve many substances insoluble in the water itself, such as calcic carbonate, occurring in the soil as marble, limestone, or chalk, and also the carbonates of iron and magnesium. If we examine a spring water, we shall find that its dissolved impurities can be divided into two classes; for instance take the Kent water supplied at Greenwich, obtained from deep wells in the chalk, we find its saline constituents in grains per gallon are:

Calcic carbonate	16·30
Calcic sulphate	5·37
Magnesic sulphate	0·93
Magnesic nitrate	1·20
Sodic chloride	2·64
Sodic nitrate	1·21
Silica, alumina, etc.	0·97

And of these the calcic sulphate, magnesium, and sodium salts are dissolved by the solvent action of the water in the same way that sugar would be, while the chief impurity, calcic carbonate, is scarcely at all soluble in the water itself, 16,000 parts of pure water only dissolving one part of the carbonate, but is readily soluble in the carbonic acid, in the water which converts it into soluble calcic bicarbonate.

In the household, waters are roughly classified as hard or soft waters, and the property of hardness manifests itself, as a rule, to the householder by its action upon soap, and also by the amount of "fur" which it causes in the kettle, these actions being due to calcic bicarbonate, calcic sulphate, and the magnesium salts present in it, all of which act upon soap and cause it to curd instead of forming a lather by converting the soluble sodic oleate and stearate into insoluble lime salts, while the bicarbonate, by decomposing and depositing "chalk," causes the fur.

EREMURUS ROBUSTUS.

A more careful examination, however, reveals the fact that this property of hardness owes its origin to two different causes; for if we boil water until all the bicarbonate is broken up and the calcic carbonate deposited, the clear water left behind it is yet hard, though to a far less extent, and will still decompose a certain proportion of soap. The hardness, which can be got rid of by boiling, is due to bicarbonate of lime, and sometimes also bicarbonate of magnesia, and is called "temporary hardness," while the hardness left after boiling the water is due to calcic sulphate and the soluble magnesium sulphate, chloride and nitrate, and is called "permanent hardness."

The relative hardness of waters is estimated by the amount of soap they will destroy—i. e., convert from the form of soluble sodic oleate and stearate into the condition of insoluble oleates and stearates of lime; and one grain of calcic carbonate, or its equivalent in sulphate or salts of magnesia, dissolved in a gallon of water, is said to equal 1° of hardness.

THE EREMURI.

With a little trouble eremuri may be grown successfully by every lover of beautiful flowers. All that is necessary for their well-being is protection from slugs, which soon scent them from afar. I keep a perforated zinc collar round the crown and protect them from spring frosts. The plant early forces its way up even through the frost-bound earth, but the tender flower-spike, tender only in infancy, is nipped in the bud if rain fall on it and freeze. Protection also from cutting winds which destroy the foliage is needed. With such precautions and planted in loam, deep, but not too stiff, in a well drained sunny border, and with an occasional dose of weak liquid manure, they will repay one for all the care given to them. The varieties that I grow of this little known genus are E. himalaicus, which grows from 6 feet to 8 feet high, and E. Bungei, 4 feet to 6 feet high. Both are different in color and height from E. robustus, the one figured, which when last measured was 10 feet 8 inches high, and had not then expanded in all its flowers, but they are quite as beautiful. Of E. Olgæ I can say that it existed only for three years here, and this summer, after making but a feeble growth, it died. I have been told that it is quite distinct in habit from the others, flowering a little later, and growing from 4 to 6 feet high. I have seed of E. himalaicus and E. Bungei, which sown last autumn started into growth this spring. Seedlings are years in coming to maturity, and this will account for the rather high price of strong flowering plants.—F. Page Roberts, in the Garden.

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